Italian Coast Guard - APAT/ARPA - ICRAM

Italian Ministry of Environment Mission in Lebanon

Activity Report

September-November 2006

The “Bahar” environmental mission in Lebanon started on September 12th 2006, when the Italian Coast Guard (ITCG) ships left the port of Messina, in Italy.

The chronology of the mission can be summarised as follows:

- 24.08.2006: the Lebanese Minister of the Environment sends to the Italian Ministry of the Environment a formal request for an intervention in Lebanon to support the clean-up activities following the Israeli bombing at Jieh power plant;
- 07.09.06: the Italian Ministry of the Environment positively replies to the for the formal request and sends some experts for a preliminary survey;
- 19.09.2006: the Lebanese Ministry of the Environment extends its request by asking for an aerial surveillance (remote sensing) by the Italian Coast Guard, that arrived in Larnaka Cyprus on the 27th September;
- 20.09.2006: the ITCG “Peluso” arrives in the Beirut port ;
- 21.09.2006: the ITCG “Peluso” and Coast Guard Divers starts operations in Jieh ;
- 27.09.2006: the S/V “Tito” arrives to Jieh port;
- 28.09.2006: Castalia starts operations with S/V Tito;
- 14.10.2006: assessment of the area completed and 40 tons of pollutant recovered ;
- 04. 11.2006: S/V Tito leaves to Italy for turn around;
- 09.11.2006: ICRAM/ARPA dive with “Bahar Lubnan” for area survey ;
- 10.11.2006: ICRAM/ARPA dive with “Bahar Lubnan” for area survey ;
- 11.11.2006: ICRAM/ARPA dive with Coast Guard for area survey ;
- 14.11.2006: up to date “Bahar Lubnan”, with the indications given by ICRAM/ARPA divers has recovered ten more cubic meters of pollutant .

The mission is composed by the ITCG, the national and regional environmental agencies of Italy (APAT/ARPA), ICRAM and Castalia/Ecolmar (contractor of the Italian Minsitry of the Environment).

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REPORT ON THE ACTIVITIES
LEBANON COAST SEPTEMBER 13 – NOVEMBER 13

INDEX

Introduction

In the framework of the Italian environmental intervention in Lebanon, the main objective of the participation of the Italian Environmental Agency Network (i.e., APAT, A*genzia nazionale per la Protezione dell'Ambiente e per I servizi Tecnici*) and ARPAs, Regional Environmental Protection Agencies - specialized on coastal pollution and control: Emilia-Romagna, Liguria, Toscana and Sicilia) and ICRAM (*Istituto centrale per la ricerca scientifica e tecnologica applicata al mare*), is to provide technical-scientific co-ordination and direction in order to guarantee sound scientific basis and environmental sustainability to the investigation and clean-up activities. So far, the following main activities have been carried out:

- control and clean-up of the stretch of sea facing the power station located in Jieh;
- sampling and monitoring activities in the Lebanese coastal and marine region, aimed to the attainment of an experimental verification of the dynamic spreading of the oil spill and a preliminary determination of its environmental impacts;
- control of the seafloor in the archipelago of Palm Islands and in other costal areas suitable to be affected by submerged oil;
- forecasting of weather and sea-conditions in the region of interest (Levantine basin, 48 hours);
- preparation of guidelines specifically related to the clean-up of the Lebanese coasts.

The primary purpose of reclamation operations is to minimize the environmental damage and to achieve a sustainable environmental restoration. In a specific situation, this means also to adopt criteria and to carry out reasonable and technically feasible activities in order to improve natural recovery, where possible, and to avoid further environmental damage which could be caused by the desire of eliminating the whole pollutant or, at least, the visible one.

In the following pages is a summary report of the activities undertaken by the Italian Environmental Agency Network (APAT and ARPAs) and ICRAM, up to the time of writing.

Participation to OSOCC meeting

The technical-scientific component of the Italian delegation attended all the OSOCC (Oil Spill Operation Coordination Centre) meetings. Daily reports – summarizing the activities carried out – were prepared and distributed as well as plans for the following day and proposals concerning activities carried out by other delegations and about the generated waste management were provided and considered.

Monitoring and technical-scientific supervision

Monitoring and technical-scientific supervision and co-ordination of the activities implemented in Jieh:

- clean-up and protection of the cooling water intake of the power station (activities undertaken by Castalia-Ecolmar, Coast Guard and the NGO Bahar Lebnan);
- collection of oil residuals from the seafloor, preparation and transfer of the generated waste.

Working notes and detailed photographic reports were periodically delivered and presented at the OSOCC meetings.

A particular attention was focussed on reducing the potential risks and environmental damage related to clean-up activities, as:

- avoiding to affect, simultaneously, elements of both fauna and flora - which can be fundamental for the future environmental recovery of the impacted area;
- avoiding the alteration of the habitats;
- avoiding to modify the physical and chemical characteristics of marine habitats (e.g., sand removal, alteration of the ratio between the different granulometry fractions of marine sediments, etc.).

Technical documents

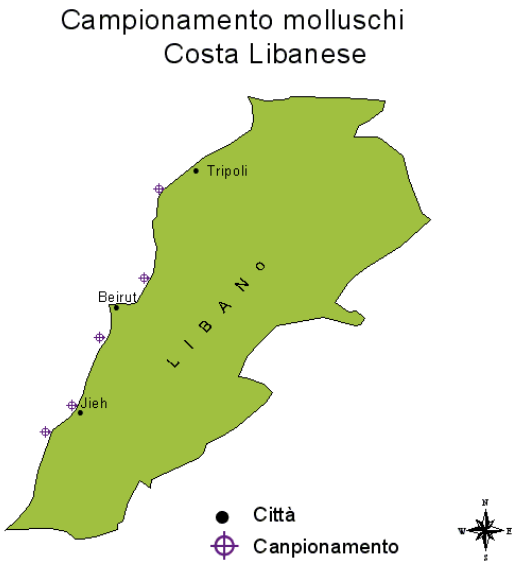
Drafting of technical documents and guidelines, finalized to the support of operational activities:

1. characterization and recovery of the Jieh’s power plant site.

2. clean-up of coastal areas ('*Guidelines for Remediation of the Coast of Lebanon Contaminated by Oil - scientific and technical aspects to consider when carrying out clean up and remediation activities of the Lebanese coast contaminated by oil in July 2006*' – see Appendices);
3. procedures for management and storage of the clean-up generated waste ('*Waste Management Options*' prepared on the basis of existing guidelines prepared by CEDRE) and '*Suggestions for a field cataloguing and characterization of the recovered oil from sea*' – see Appendices;
4. Indications on 'good practices' for oil spill waste minimization and management '*Lebanon Marine and Coastal Oil Pollution – Guidelines for Waste Management'*– see Appendices;
5. a document about the environmental situation and the present potential sources of environmental pollution at the site of the power station ('*An assessment of the Power Station Site in Jieh'* – see Appendices);
6. a brief document containing '*General recommendations for the characterization and recovery of Jieh power plant*' – see Appendices.

Monitoring and sampling

Six monitoring sampling points along the Lebanese coast were selected and geo-referenced (see map). In each of these sampling points, in collaboration with Greenpeace, *Spondylus* specimens (a mollusc) were collected as representative biological indicators and analyzed, in collaboration with a Lebanese University.

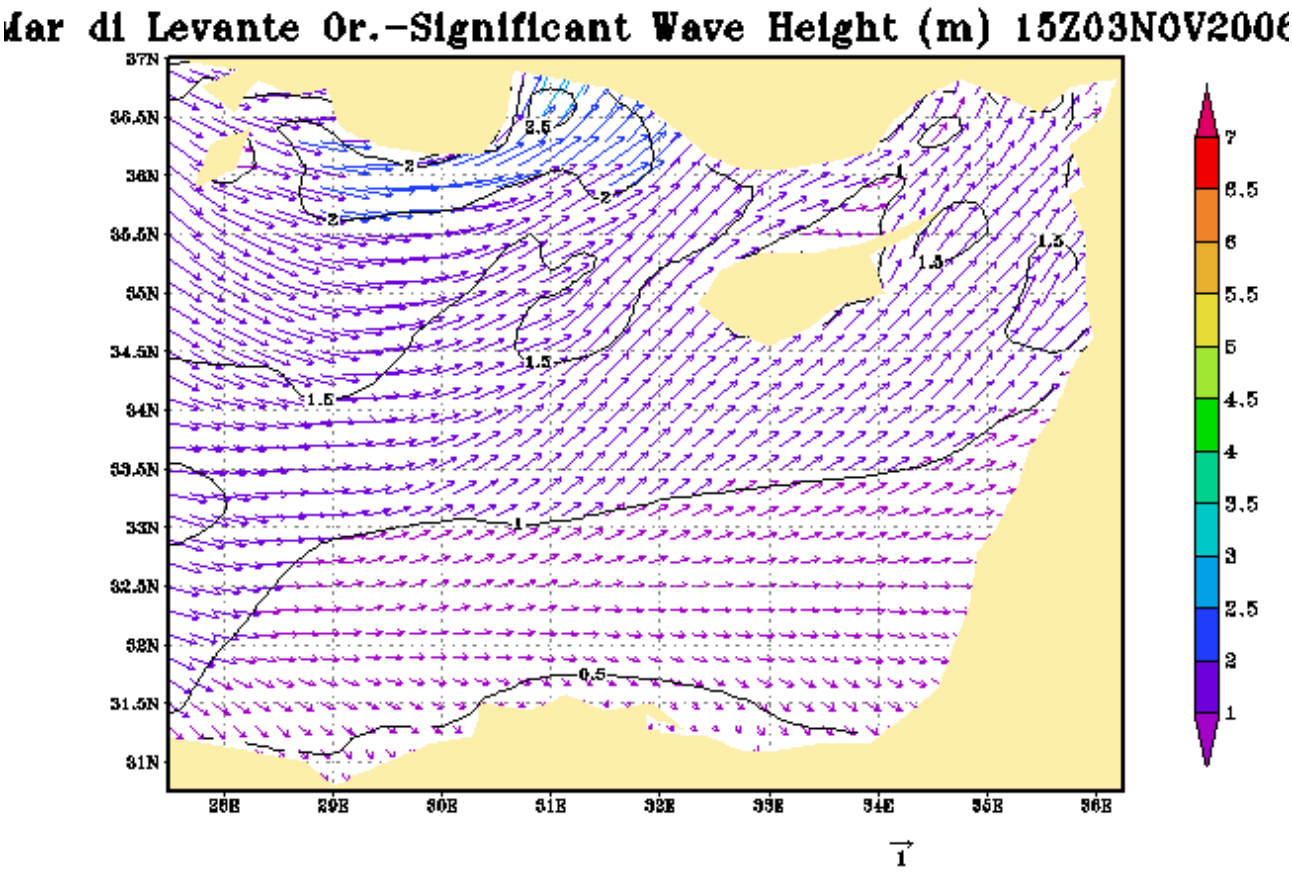


A control activity based on fish samples is going to complement the above mentioned one based on Molluscs by collecting specimens of two species (*Mullus surmuletus - Soultan Ibrahym Sakhry*, bottom dweller and *Lithognathus mormyrus – Marmour*; a bentho-nektonic species – see '*Fish sampling - basic protocol*', in the Appendices) in three representative sampling points: Sour, Beirut and Byblos.
Two sediment cores and four seawater samples were taken in Jieh, one in an area strongly polluted by the oil spill (grid square '9C'), the other, south of the Jieh site, to be considered as representative of the 'background'. The following analysis are planned for the collected sediment samples: granulometry, heavy metals, ecotox, micro-pollutants (e.g., PAH, PCB).

The 'S' sector (square grids, 'S1' - 'S10') of the sea region directly facing the fuel storage tanks of the power station has been inspected by marine biologists aiming at the attainment of a characterization of the benthic assemblages where, on the rocky outcrops, the zoobenthos is preponderant with respect to the phytobenthos.

Forecast of the marine and weather conditions

A weather forecast modelling platform was implemented for the Lebanese region of interested (Levantine basin wind and sea state forecast, based on the APAT "Sistema Idro Meteo Mare" forecasting system) and routinely operated. Daily generated complete sea state and weather forecast, up to 48 hours, were made available for download - on a daily basis - from the APAT web server (http://www.apat.gov.it/pre_mare/home_lib.html) and/or distributed to concerned actors.
The sea state and the wind speed were forecasted by the mean of the WAM (WAve Model) and QBOLAM (Quadrix BOlogna Limited Area Model) model, respectively. Both models are integrated in the APAT atmospheric and marine forecast system (SIMM).
An extract from the daily bulletin is reported, as an example:



forecast for the day in which the bulletin is emitted:

- SEA STATE: South-western waves with significant height of around 1.5 m at 12 UTC and decreasing in the afternoon.
- WIND: South-westerly winds with speed between 6 and 8 m/s.

forecast for the following day (up to 48 hours):

- SEA STATE: In the morning, western waves with significant height of about 1.0 m. After 12 UTC, waves come from south-west and the significant height rises up to 1.5 m (e.g., at Tripoli site).
- WIND: South-westerly winds with a maximum speed of 12 m/s in the morning. After 12 UTC winds change direction, coming from the south and their speed decreases.

Technical-scientific collaborations

Technical-scientific coordination of underwater controls and shellfish sampling (implemented by Greenpeace) were performed in the Jieh area, from Beirut to Byblos and in the region of the Palm Islands.

In collaboration with IUCN (International Union for the Conservation of the Nature), with the aim of evaluating the most visible impact of the oil spill on the coast and on the sea

bottom, preliminary inspections were undertaken in the Marine Protected Area of Palm Island. In the initial phase, however, the rough sea didn't allow a systematic monitoring of all the Marine Protected Area. Consequently, the attention was initially focused on a single spot (Palm Island). Half of the island perimeter was observed by land, and a lot of still contaminated places were found. An initial underwater survey was performed only in a 'sample area', in shallow waters, where only a single oil spot of just 30 cm diameter was found. The sea bottom appeared poor of flora and sessile marine organisms, even if vagil fauna, like fish, was abundant in juvenile specimens. In agreement with IUCN, it is considered very important to investigate the area. Further dives performed by marine biologists, utilising DVPs (Dive Propulsion Vehicles), allowed the underwater inspection of the whole perimeters of two islands (Ramkine and Palm). No submerged oil was detected.
A further collaboration was undertaken with IUCN aimed at the preparation of a common project aimed at the assessment of the present marine features in the archipelago of the Palm Islands. The project rely on the implementation of a permanent environmental monitoring system (sea and inland) and the definition of 'clear rules' for a rational and sustainable use of the natural resources. Such a project should allow a re-valorisation of the islands from the point of view of a nature oriented and compatible form of tourism. Such an objective should also include environmental awareness raising and educational actions and campaigns aimed at the creation of 'eco-tourism itineraries' in Palm Islands.

Aiming at a future long-term collaboration, contacts were established with experts from UNEP, IFREMER, CNRS and Lebanese Universities for a potential future project aimed at the assessment and monitoring of the oil spill impact. Such a project should aim to the attainment of a financial support by the European Commissions. The scientific and technical component of the Italian delegation, in cooperation with IUCN, IFREMER, University of Cyprus and Lebanese local researchers and operators, should prepare a comprehensive monitoring plan that should necessarily include the three environmental media: water column, sediments and pore water/elutriate and biota. The following lines of investigation will be included in the aims of the potential project:

- chemical and physical quality of water, sediments and related risk impacts (in terms of human health);
- impacts on landscape preservation;
- impacts on fishing activities;
- impacts on local and international tourism related activities.

Dissemination activities

Creation of a dedicated web-site, accessible from the main server of APAT, specifically aimed at the collection and sharing of information related to the Italian Mission in Lebanon. This web site (http://www.apat.gov.it/pre_mare/home_lib.html) is a focal point for the dissemination of the technical documentation produced in the framework of the Mission, as well as the weather forecasts provided on a daily base for the Lebanese region of interested (the forecasts are produced by Italian Environmental Agency Network itself).

In the next few months it is planned to organize a workshop in Italy, dedicated to the sharing and dissemination to the governance and scientific communities of the experiences and the 'lessons learnt' in the framework of the activities in Lebanon.

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APPENDIX 1

'Guidelines for Remediation of the Coast of Lebanon Contaminated by Oil - scientific and technical aspects to consider when carrying out clean up and remediation activities of the Lebanese coast contaminated by oil in July 2006'

This paper reports procedures and best practices for the clean up and restoration of the coast of Lebanon following the oil spill occurred from the Jieh power utility (30 km south of Beirut) on 13 and 15 July 2006 as a consequence of an act of war.

Important: the content of this document derives from the direct experience of the authors, from the observation of the contaminated Lebanese coast as well as from the information provided by international Guidelines and Manuals produced by ITOPF (International Tanker Owners Pollution Federation, www.itopf.org) and CEDRE (*Centre de Documentation, de Recherche et d'Expérimentations sur les Pollutions Accidentelles des Eaux*, www.cedre.fr)

The aim of the document is to provide the competent authorities with the necessary information in order to minimise the impact on the Lebanese coast due to oil contamination. A specific action plan shall be developed for each impacted site, taking into account several aspects such as accessibility, extension, economic (tourism, fishing activities, etc.) and environmental sensitivity.

Clean-up effort should be first directed to areas which have the heaviest concentrations of mobile oil. If it is persistent and therefore resistant to natural breakdown and dissipation, it will act as a reservoir for contaminating additional stretches of the coast or for the re-oiling of previously cleaned areas. Moreover, such residues may become heavier than water if they accumulate sufficient sediment, which will result in sunken oil on the sea bed. Such sunken oil can be re-mobilised by storms, thereby re-contaminating previously cleaned areas.

Shoreline clean-up is usually carried out in stages, starting with the removal of waste material, which has been observed in huge quantities along the investigated Lebanese coast. The second phase will concern the removal of the heaviest accumulations of oil. Clean-up ideally should not begin until heavy accumulations have been removed (mobile oil) and the risk of recontamination by floating oil has receded. The need for secondary cleaning and the degree to which it is carried out must be judged against the use of the shoreline and economic and environmental sensitivities. The final traces of oil are often difficult and time consuming to remove. In many instances natural degradation processes deal with them quickly and effectively.

Clean up operations shall be carried out with the aim of minimizing waste volumes. It is important to keep different kinds of waste (pure oil, oily sand, oily debris, plastic, washing liquids) segregated as this considerably simplifies final disposal. Depending on local regulations, the different wastes can be sent through different final disposal routes. In particular, pure liquid oil can be recycled.

Remediation activities should be carried out bearing in mind both the need to eliminate or to reduce the amount of pollution along the coast and the necessity to minimize the eventual environmental impact that the above mentioned activities could cause. The literature on this topic reports several cases where an excessive cleaning of the beaches led to serious environmental damages often worse than the pollution itself (e.g. excessive removal of sand, removal of dunal vegetation, ecc).

Clean up activities should concern four different types of coast: rocky beaches and man made structures; sandy beaches; pebble beaches; cliffs.

In any case all operators must be provided with protective clothing and safety equipment in order to minimize the risk of contamination.

Interventions on rocky beaches

The first operation to be done (after removal of waste material) is to recover the bulk oil. This operation can be carried out manually or through vacuum units or other skimmers on pooled oil. Low pressure flushing with sea water may also be employed to wash oil residues to collection points.

Figure 1. A low pressure water pump utilized to collect bulk oil (source www.cedre.fr)

Clean up activities should proceed with two more phases: manual recovery of bitumen residues and final cleaning through a high pressure water pump. Such procedure minimizes the quantity of oil products which could enter the marine environment.

Figure 2. A high pressure water pump utilized along the rocky littoral

When utilizing the high pressure water pump it is recommended to use only cold water in order to avoid further damage to the fauna and flora of the mediolittoral zone. In case this technique does not work properly the possibility of utilizing hot water may be considered. Such "aggressive" techniques should be used with caution. In many cases natural degradation processes result more effective.

Absorbent papers will be positioned at a certain distance from the intervention area and before the shoreline in order to recover the oil washed off the rocks by the cleaning activities. As a further protective measure, within the stretch of sea just in front of the area where clean up operations are taking place, absorbent booms and equipped operators will be ready to recover any oil product reaching the sea. It is important to take into consideration that the sorbent materials could increase significantly the volume of waste and that some sorbent materials require a specific and costly disposal. The use of classical booms and skimmers could be more appropriate, whenever the hydrografic conditions allow their employment.

Figure 3. Absorbent papers and booms

Clean up activities of this particular beach type must take place only with good meteo-marine conditions.

Interventions on sandy beaches

Particular care needs to be taken in order not to remove excessive quantities of sand or to mix the oil deeply into the beach substrate. Manual collection of the oil is generally preferred to mechanical removal with machinery.

As for the rocky shores, the first operation to be carried out (after removal of waste material) concerns the recovery of heavy accumulations. This action could be accomplished through the use of wooden scrapers which allow a significant separation of oil from sand. The material is then collected manually with shovels and rakes and stored in dedicated tanks.

Figure 4. A sandy beach partially cleaned by wooden scrapers (source www.itopf.org)

Final cleaning options may include the manual removal of tarballs and oil fragments or the use of specific beach cleaning machinery, such as tractor drawn units which are usually employed to collect rubbish and debris from beaches during the touristic season.

Figure 5. A specific device normally used to clean touristic sandy beaches (source www.cedre.fr)

In some circumstances, once washed ashore the oil can be buried under a sandy layer (sandwich structure). In this case low pressure flushing with sea water could result the most appropriate technique to remove the buried oil while the use of sorbent materials or booms and skimmers are recommended for the collection of it.

Figure 6. Low pressure flushing of a sandy beach contaminated by buried oil (source www.cedre.fr)

Interventions on pebble beaches

In this case, pebble washing in a mortar mixing machine is considered the best solution. The machine should have proper dimensions as it needs to be easily transported on site

and positioned on the beach. Pebbles are collected by means of a shovel and included in the mixing machine. A solvent able to effectually dissolve hydrocarbons is added leaving it for a few minutes to act; finally hot water is added to complete the washing operation.

Figure 7. A mortar mixing machine utilized for cleaning pebbles contaminated by hydrocarbons (source CEDRE, www.le-cedre.fr)

With the aim of minimizing the quantity of waste following the washing operations, the volumes of water, solvent as well as the time necessary to complete the activity will be assessed through a preliminary test. Once the washing operation is over the content of the mixing machine is poured into a container having an upper grid able to retain the pebbles and to let the washing liquid pass. The pebbles on the grid are once again washed with water by means of a high pressure water pump in order to eliminate any residue of solvent and/or hydrocarbons. Finally pebbles are repositioned on the beach taking care of maintaining the original profile of the beach.

Interventions on cliffs

In case the investigations carried out along the coast will reveal the presence of oil residues on cliffs and/or on partially submerged caves it is suggested to intervene with a small motor boat able to reach the rocky wall. Clean up operations are performed through manual recovery, utilizing a metal spatula while on board the boat. This rough cleaning will leave on place small patches of oil which will degrade naturally. Also in this case clean up operations are carried out only with good meteo-marine conditions.

Preparation of the working site and waste disposal

The working site must be clearly visible and interdicted to non authorized personnel. It is highly recommended to identify well-marked areas dedicated to the stockage of the recovered material and to the clean up of material and personnel once the operations are concluded.

Figure 8. Clean up of personnel once operations are concluded

In both cases the areas should be covered with specific material, able to avoid liquid pollutants infiltrations (e.g. geotextile), and circumscribed by cuttings for the collection of liquids accidentally leaked from the containers and/or deriving from the clean up operations. When deciding the location of the above mentioned areas both their accessibility and the vegetation coverage should be taken into account in order to minimize the environmental impact. In case alteration occurs it is reasonable to foresee an environmental restoration.

The containers for the stockage of the recovered material should be properly marked with a specific code indicating both type and quantity of the stored waste. The collected waste material should finally be taken to an authorized discharge or to oil refineries for the partial recovery of the hydrocarbon fraction.

The entrusted firm should then provide the proper documentation attesting the arrival of the waste material to the authorized discharge or to the refinery.

On field activities report

With the view of sending a request for compensation of both the possible damages occurred and the costs for clean up operations to the International Oil pollution

Compensation Fund (IOPCF), it is necessary to register all the daily activities which have been carried out. Thus a clear picture of the material and the personnel involved is provided.

It is recommended to specify the title of the employed personnel, their hourly/daily cost and the total working hours while for the material it shall be sufficient to report their unit cost, the quantities which have been utilized and the duration of their employment. Finally it is necessary to report the daily quantities of the waste recovered. A standard reporting form which could be useful when registering data is reported below.

CLEAN UP AND REMEDIATION ACTIVITIES OF THE COAST OF LEBANON

DAILY ACTIVITIES REGISTRATION FORM

FORM N°___ OF___

DATE _____

SITE _____

OPERATOR _____ TITLE_____

PERSONAL

Name	Title	Unit cost (hourly/day)	Hours of work

MATERIAL

Type	Quantity	Unit cost	Quantities used

WASTE PROPERTIES

type/class of waste	Quantity	Stock site	Disposal site

Signature of the coordinator of activities_____

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APPENDIX 2

'*Waste Management Options*'

WASTE MANAGEMENT OPTIONS

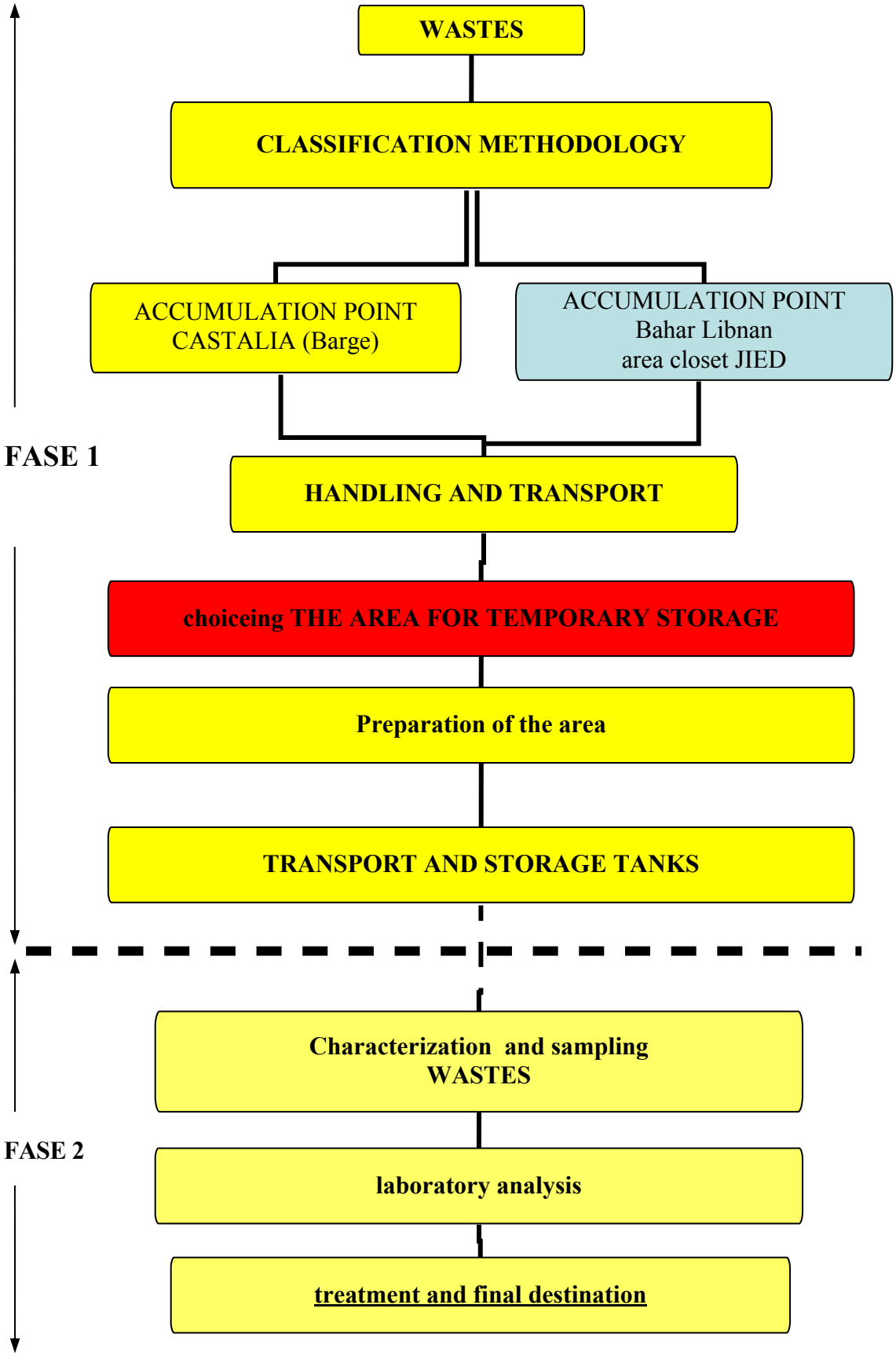
update : 05 October 2006

Type of waste	Quantity Rough estimate m^3	Intermediate Storage Beach storage	Temporary storage location and capacity (regular feeding of the treatment facilities)	Intermediate phase	Final Treatments*
liquid oil recovered by dredge, skimmers or manually (pooled oil)	1000	- tanks in plastic containers watertight	Soliver glass manufacture (Chalde) 4,000 tons tank		-Soliver
Sunken oil collected in plastic bags (more or less burnt oil)	100	- oil in plastic bags placed in plastic containers watertight	temporary storage out of beaches to be organised (private owned)		Soliver ? necessity to separate oil from plastic bags ?
Oily sand	100 -200?	- more or less oily sediment collected in plastic watertight containers or plastic bags	-if minor contamination back to the sea with oil recovery - if major contamination : safe temporary storage	characterization	-treatment cementery? -quick lime treatment?
Sunken oil collected by vacuum pump with minor quantity of sand (Italian team)	200 to 600 ?	- plastic containers watertight - metallic drums	one safe temporary storage area to be prepared on private owned land and built by private company 2000 m^2	- characterization of burnt oil - sampling waste	- Soliver ? - quick lime treatment?
Oily debris (plastic, woods, textile....) Protective suits, boots, sorbents	1000 4000	- drums - tanks - plastic containers watertight		-check cement factory specifications	- burnt in cement factory? - mobile incinerator?

***Local treatment options should be a priority versus oily debris exportation for treatment**.

WASTE

Flow Chart



WASTE STORAGE FOR OILY DEBRIS

ÉTANCHÉITÉ DES SITES DE STOCKAGE

Les sites de stockage de MPP doivent systématiquement s'accompagner d'un dispositif d'étanchéité afin de limiter l'impact sur l'environnement et en particulier prévenir les infiltrations et la contamination par ruissellement.
L'étanchéité peut être assurée grâce à différents types de matériaux, en général des géomembranes ou des films plastiques.

***Les géomembranes** sont des produits souples dont les caractéristiques techniques et les conditions de mise en œuvre sont normalisées. Celles qui sont recommandées pour les hydrocarbures sont en PE HD (épaisseurs courantes 1,5 ou 2 mm en rouleaux de 100 m pour des largeurs de 5 à 10 m). L'étanchéification est réalisée par soudure, mise en oeuvre par un applicateur spécialisé.*

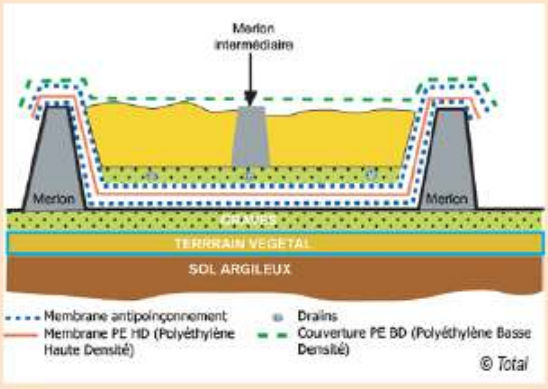
***Les films plastiques** type « polyane » sont des bâches utilisées en particulier dans l'agriculture ou dans le bâtiment, d'épaisseur en général inférieure à 0,25 mm. Ils sont beaucoup plus souples et malléables, moins onéreux, et plus facilement disponibles (coopératives agricoles, grossistes en matériaux BTP) que les géomembranes. Ils sont cependant moins résistants au poinçonnement, au cisaillement et à la traction. Il convient donc de les utiliser en plusieurs épaisseurs et de les associer à des géotextiles*.*

Lorsque l'objectif est simplement de former un écran anticontamination sous des bacs ou bennes étanches, disposer un film plastique ordinaire en prenant soin de préparer convenablement le sol. Interposer un géotextile entre le sol et le film plastique afin d'éviter la perforation de ce dernier.

Pour le stockage en vrac de polluant pâteux, les lés peuvent être posés sans soudure ou collage mais en assurant un quadruple recouvrement par pliage des deux feuilles l'une sur l'autre. Placer un géotextile en sous couche pour limiter le poinçonnement et croiser les couches successives.

Lors de la création d'alvéoles de stockages intermédiaires et lourds, l'étanchéité doit être réalisée avec beaucoup de rigueur et requiert une technicité particulière (choix des géomembranes, soudure des lés...). Il est recommandé de tapisser les alvéoles du bas vers le haut par un géotextile anti-poinçonnement, une géomembrane résistant aux hydrocarbures, un deuxième géotextile anti-poinçonnement et une couche de sable en protection de roulement d'engins de chargement et déchargement.

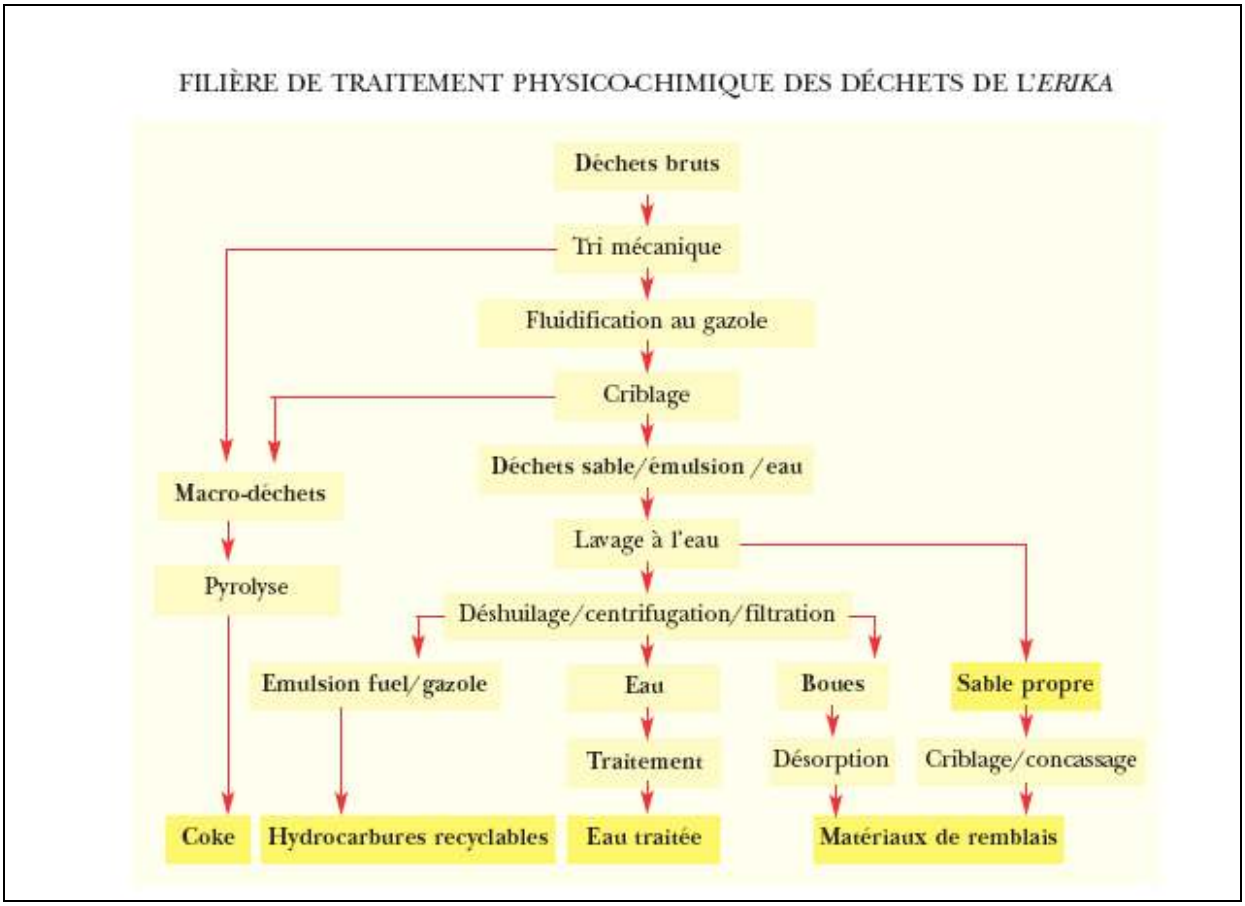
*Les géotextiles sont des feutrines synthétiques, d'un poids surfacique compris entre 300 et 500 g/m² en rouleaux de 100 m et de différentes largeurs (3, 4, 5 m voir 6 m), utilisées en sous-couches destinées à limiter le poinçonnement des géomembranes et films d'étanchéité.



Pour plus d'informations sur les géotextiles et géomembranes consultez le site Internet du Comité Français des Géosynthétiques http://www.cfg.asso.fr

Coupe structurelle du stockage lourd des déchets de l'Erika.
Donges, Loire-Atlantique (44).

OILY WASTE FROM ERIKA SPILL : EXEMPLE OF TREATMENT



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APPENDIX 3

'Suggestions for a field cataloguing and characterization of the recovered oil from sea'

The waste management is one of the main steps among the cleanup operations.

The knowledge of the total amount of recovered oil and of their characteristics are the crucial points in order to decide its final destination (recycling, reusing, disposal).

In order to know the total amount of oil waste collected along each cleanup site could be useful to label the containers/tanks/drums utilized for the storage of the product applying a unique code that allows to follow them along all the possible intermediate storage areas until the final destination.

An alphanumeric code could be applied with the aim to track the container that should include information on the area of collection, the workers team who gathered it, the container progressive number and its volume.

The Italian delegation is now proceeding with the labeling of all the tanks located in Jieh where the sunken oil collected by divers is stored (Fig. 1).

Figure 1

In the example showed in figure 1 the code is J BL 006 A

J Jieh

BL Bahar Loubnan NGO

006 progressive number (you start form 1 up to the total recorded number of tanks of each type)

A tank with a volume of 200 liters with certain characteristics

The “waste code” must be unique for each tank and for each “waste code” it must be a “waste code - form” where more information is specified:

volume, type of product, period of collection, waste in bulk or in plastic bags, density, debris percentage in volume and in weight.

Example

WASTE CODE = JBL006A

WASTE CODE- FORM	**JBL006A**
Type of waste	Sunken oil
Collected during	10-27 sept. 2006
Area of collection	Jieh power plant
Worker team	Bahar Loubnan NGO
Tank number/ Total tanks number	006/025
Tank volume	200 liters
Waste volume	180 liters
Oil recovered in plastic bags	YES
Density (g/cm^3)	1,21
Debris Percentage in weight	50%
Debris Percentage in volume	10%
Others, comments, etc.	

If waste gathered in different containers/tanks/drums must be pooled, for any reason, the data indicated above should not be calculated until the containers/tanks/drums will be in a temporary storage. In particular, the data to be estimated successively are: waste volume, oil recovered in plastic bags, density, percentage in weight of debris, percentage in volume of debris.

!) How to measure on field the density of oiled waste

Density could be easily measured using a jar with a known volume (es. a vial) (V_{jar}).

First of all, it is necessary to know the empty jar weight (W_1). Then, the jar must be fully filled with oil waste and weighted (W_2). The difference $W_2 – W_1$ gives the value of oil waste

in weight (W_3). An estimate of density c an be easily done as the rate weight/volume: Oil density = W3/V.

2) How to measure on field the debris percentage in weight

Using the same jar filled with oil waste, it could be useful to eliminate the oil adding a organic solvent like diesel or gasoline. It is necessary to shake continuously to solve completely the oil (about half an hour). At the end of the operation, the liquid mixture is eliminated and the debris remaining in the jar is weighted (W_{debris}).

The debris percentage in weight can be calculated as follows:

W_{debris}: W_3 = $\%W_{debris}$:100;

$\%W_{debris} = W_{debris} \bullet 100 / W_3$

3) How to measure on field the debris percentage in volume

With the aim to evaluating the debris percentage in volume, the jar used has to be furnished of a graduate scale of volumes in order to allow a fast measurement of the remaining debris volume (V_{debr}).

The debris percentage in volume can be calculated as follows:

V_{debris}: V_{jar} = $\%V_{debris}$:100;

$\%V_{debris} = V_{debris} \bullet 100 / V_{jar}$

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APPENDIX 4

''Lebanon Marine and Coastal Oil Pollution – Guidelines for Waste Management''

1.INTRODUCTION

In designing and implementating a waste management plan the following principles must be taken into account:

- reduction of waste generation;
- reuse of waste materials for productive activities;
- recycling of waste materials (before and after treatment)

As a general condition waste materials must be managed without posing any risk to human health and the environment.

In the application of the above mentioned general principles for the management of the waste produced by clean-up activities at El Jyhe power plant (30 km South of Beirut) the following specific barriers should be considered:

- emergency situation following the acts of war of July-August 2006;
- lack of human, financial and technical resources;
- lack of clear regulations and/or action plans on waste management;
- social and political constrains.

The present paper reports some indications on the best practices for oil spill waste minimization and management in order to provide the lebanese authorities with the technical information for the development of a waste management plan for the contaminated lebanese coasts.

2. WASTE MANAGEMENT

A useful model when developing a waste management plan is the so called "waste hierarchy", represented in Figure 1.

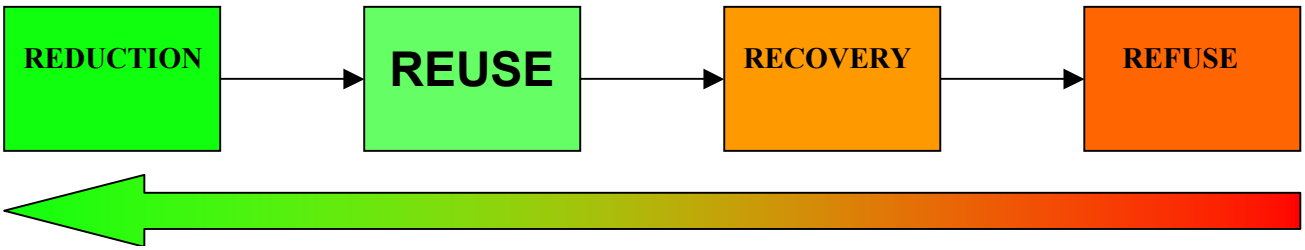

Figure 1: Waste hierarchy model (modified after IPIECA, 2004)

The strategy represented in Figure 1 can be summarised as follow for the case of an oil spill:

- reduction: during the oil spill clean-up actions the minimum material must be used and/or contaminated;
- reuse: clean-up equiment should be cleaned and re-used as much as possible;
- recovery: the production of marketable products from waste must be enhanced (e.g. waste oil can be used in the incineration plants;
- refuse: is the less desiderable option in case of unseparable and highly polluted wastes that cannot be economically and efficiently managed through the previously mentioned options.

2.1 Segregation and tracking of waste streams

Oil and oiled debris produced during the clean-up operation should be segregated, stored, treated, recycled or disposed of. The segregated waste streams should be segregated at source and sent to separate storage types.

It is also essential to point out that after the segregation, each waste stream must be tracked from the point of generation to the point of disposal. The quantity of waste produced for each category should be registered and carefully documented. The local control authorities should assure that all the generated waste is correctly and safely handled, stored and prepared for final disposal.

The oil recovery operations should generate the following waste types:

- Oil + Water
- Oil + sediment/sand
- Polluted Sand
- Polluted Sediment
- Polluted Pebbles
- Oiled Solid Waste (wood, plastic, bags, clothes, tanks,etc.)
- Oiled Sorbents
- Pure Oil
- Oil + Solvents

According to the Commission Decision of 3 May 2000 replacing Decision 94/3/EC establishing a list of wastes pursuant to Article 1(a) of Council Directive 75/442/EEC on waste and Council Decision 94/904/EC establishing a list of hazardous waste pursuant to Article 1(4) of Council Directive 91/689/EEC on hazardous waste, the above mentioned waste types should be tracked by the European Waste Catalogue (EWC). The appropriate EWC class should be:
13 Oil wastes and wastes of liquid fuels (except edible oils, 05 and 12)
It is worth mentioning that, according to the indication of the European Commission, the above mentioned waste types should be classified as hazardous waste if the total hydrocarbons content is higher than 0.1% (1.000 ppm).

2.2 Minimization
The amount of produced waste should be reduced through the effective use of the equiments, the use of reusable personal protective equipent, the prevention of generation of liquid and solid waste through the application of containment measures for the contamination.

2.3 Secondary contamination
During the clean-up activities secondary sources of contamination can be created by spreading contaminants to unpolluted areas via personnel, transportation devices and equipment. To prevent this the following actions must be undertaken:

- delimitation of clean and polluted areas;
- checking of transportation and storage equipments for leaks;
- decontamination of all equipments and vehicles before entering the unpolluted areas.

2.4 Safety measures
The available information on the chemical, physical and toxicological characteristics of the spilled oil and the materials managed during the clean-up activities must be collected and carefully evaluated in order to develop a safety plan for the personnel involved in the works.
The safety plan should include all relevant information to assure the appropriate mitigation of the potential health risks.

3. TRANSPORTATION
Waste transportation is an operation that can be carried out at various time in the oil recovery chain. Waste transportation permits oil transfer between the collection site (where recovery, pumping and collection are carried out) and temporary and final storage sites.

3.1 Transportation on the beaches
Transfer operation output and cost depend on the adaptation of transportation means to the site characteristics and to the lenght of journeys. On sandy beaches the use of equipment ableto operate on loose grounds (ex: agricultural vehicles and cars fitted with low pressure tyres)

3.2 Transportation to waste storage/treatment sites

In case of transportation of liquid oil (recovered by skimmers) all the trucks must be waterproof. If road transportation is required, fast and large capacity vehicles should be used. Waste segregation is essential to increase transportation outputs and preference should be given to easy-to-clean equipments.

4.STORAGE

Storage options can be classified as follows:

a) on site storage: buffer beween collection phase and removal chains;
b) temporary storage: buffer while waiting for waste treatment ;
c) final storage: dumping of prducts made inert or only containing light traces of oil

4.1 On site storage

The main advantages of beach storage are:

- reduction of the consequences of unavoidable fits and starts of recovery sites; every link of the chain can thus work with its own maximum output;
- potential for a first segregation of products.

On site stoage also permits to improve the output of transportation and disposal by selecting the waste according to its consisentency (liquid, solid, pasty, dry)

4.2 Temporary storage

Waste is usually stored before being disposed of in treatment facilities. This kind of storage permits regular feeding of the treatment facilities. The temporary storage sites must be carefully designed in those cases in which the final waste treatment are not yet defined, because the waste will remain for a long time on storage sites.

4.3 Final storage

The final storage represents the last stage of waste processing and can only be achieved for solid waste that do not cause pollution of soil, subsoil, groundwater and surface water or human-health risk for thesurrounding population. The configuration and the technical requirements of these storage systems can be designed only troughout a detailed study of the selected sites in terms of geological and hydrogeological characteristics.

4.4 Storage site design

Storage site should be designed in order to combine operational requirements and environmental constrains. Operational criteria can be summarised as follows:

- taking into account the necessity of disposing very quickly of sites that, depending on the case, should be as close as possible to either the collection site or the treatment site, in order to reduce specific recovery amd transportation equipment traffic;
- building storage sites of the proper size, according to the means used upstream and downstream from the storage considered;
- designing the storage site in order to prevent contamination of soil, subsoil, groundwater and surface water (ex: prevent oil percolation by covering the storage platform with HDPE layers).

5.TREATMENT, RECYLING AND FINAL DISPOSAL

The oily waste produced during the clean-up activities should be treated, recycled or disposed without posing any risk fo human health and the environment.
The following Table identifies the potential disposal/treatment options with regard to the different categories of collected waste.

Waste Type	Treatment Options						
	Re-processing in refinery	Stabilization	In Situ Washing	Ex Situ Washing	Incineration/ Energy Recovery	Thermal Treatment	Emulsion Breaking
Oil + Water	Y	N	N	N	N	N	Y
Oil + sediment/sand	N	Y	Y	Y	N	Y	N
Polluted Sand	N	Y	Y	Y	N	Y	N
Polluted Sediment	N	Y	N	Y	N	Y	N
Polluted Pebbles	N	N	Y	Y	N	N	N
Oiled Solid Waste (wood, plastic, bags, clothes, tanks,etc.)	N	N	N	N	Y/N (pilot study needed)	N	N
Oiled Sorbents	Y/N (pilot study needed)	N	N	N	Y/N (pilot study needed)	Y/N (pilot study needed)	N
Pure Oil	Y	N	N	N	Y/N (pilot study needed)	N	N
Oil + Solvents	Y/N (study needed)	N	N	N	N	N	Y

Y = MEDIUM - HIGH APPLICABILITY
N = LOW APPLICABILITY-NOT APPLICABLE

Table 1: Potential disposal/treatment options

The cleaned sand and sediment can be returned to the beaches/sea, re-used in quarries and/or as construction materials. The potential of using the contaminated sand and sediments in the glass and/or cement industry can also be investigated following an appropriate study of the effect of contamination on the industrial process.
Used oils have been used occasionally as cutting stocks and extenders in the manufacture of asphalt. Since used oil constituents are essentially insoluble in water, potential contaminants are coated with viscous asphaltic materials and incorporated into the final product. Leaching of significant contaminant concentrations from finished asphalt roads and roofs is considered unlikely; however, the potential effects of using waste oils in asphalt production should be evaluated on a site specific basis through experimental tests (i.e: leaching tests).
The potential use of the oil residues for energy recovery should be also investigated.
The residues of the treatments that cannot be re-used for industrial purposes can be disposed in the final storage site.
It has to be pointed out that if the contamination is transferred from a solid waste to a liquid phase (i.e. in situ/ex situ washing), the liquid phase must be treated in a wastewater plant.

7. REFERENCES

- Commission Decision of 3 May 2000 replacing Decision 94/3/EC establishing a list of wastes pursuant to Article 1(a) of Council Directive 75/442/EEC on waste and Council Decision 94/904/EC establishing a list of hazardous waste pursuant to Article 1(4) of Council Directive 91/689/EEC on hazardous waste
- Guèna A., Whebe (2006): "Basic waste management reccomandation", Beyrouth, September 14th 2006, REMPEC and MoE
- IPIECA (2004): "Guidelines for oil spill waste minimization and management", IPIECA Report Series, Volume 12

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APPENDIX 5

'An assessment of the Power Station Site in Jieh'

The following activities were implemented in order to obtain a preliminary assessment of the environmental situation at the Jieh site:

- geo-referecing the positions of active and passive spills in soils;
- searching, identifying and geo-referencing points of potential releases of oil contaminants into the sea;
- geo-referecing the position of temporary storage of the collected oil wastes;
- identifying eventual uptakes of groundwater (wells and piezometers);
- first geological characterization of the area.

Main results of the activities

In parallel with the abovementioned geo-referencing activities, a visual inspection of the oil tank region and of the coastal zone affected by the oil spill was undertaken.

Tank Area

Operations of ground levelling and debris removal are still active in the region of the Jieh site damaged by the bombing. Such activities are executed without taking any particular concern towards environmental related issues: the ground of the area is still loaded with oil that, as a consequence of the strong rain and the absence of a rainwater collecting system, can freely infiltrates into the soil (see Photo 1).

While the bombed oil tanks were geo-referenced, one could notice how the tanks – whose top has been damaged or removed, are partially filled with rainwater mixed with oil residues that were still stored in the damaged tanks (see Photo 2). Care should therefore be taken in the phase of removal of the damaged tanks: the rainwater/oil residues mixture shouldn't be pumped out and dispersed without treatment on the ground of the site.

The underground tank in cement used to transfer the oil, in still in use – as confirmed by local workers and operators, however, structural damages are evident and could be potential origins of substantial spill of contaminants.

In the Southern area a (completely underground) old tank has been identified, characterized by a storing capacity of 600 m^3. This tank is presently used to store the oil to be burnt at the power station. This groundwater tank, however, appears to be heavily damaged from a structural point of view. The volume separating the tank from the outer cement containment wall was found to be partially filled by heavy fuel oil mixed to rainwater (see Photo 3).

The oil present in this volume is routinely pumped and dispersed in the environment (see Photo 4).

Water seems to accumulate on the ground in that area (see Photo 5), infiltration being relatively slow and the mixture of water and pollutants, which is only partially intercepted by the (heavily damaged) rainwater collecting system, could easily reach other sensitive `environmental objects`. It has been not possible to identify the final fate of the collected water, one could however imagine that the mixture would be, at least partially, infiltrates reaching groundwater and further dispersing in the local environment.

Coastal area

Along the coastal area protecting artificial breakwater rock-cliff, at the time of writing (end of October 2006) it is still possible to identify diffused regions where the cliffs and the rocky substrate are still soaked with fresh oil (see Photo 6). On the base of the previously reported scenario, following the indications contained in the submitted document "*General recommendations for the characterization and recovery of Jieh power plant*", one could put forwards the hypothesis that the oily mixture infiltrating in the rocky substrate, pushed by groundwater, could reach the sea and re-emerge from the rocky sea bottom. Groundwater transport and the intrusion of salt water of different densities could create a preferential dispersion path for the percolated and transported hydrocarbons. The Jieh`s typical oily residuals, slightly less dense than water and with their characteristic physical-chemical parameters could `float` along the salt water intrusion surface, re-emerging from the sea-bottom in the immediate vicinity of the coats.

Such a potential scenario is made more complex by the fact that the underground groundwater transport happens to occur in a rocky substrate, it could therefore be characterized by a long time scale: pollutants from the site could therefore reach the marine impacted area even after the objectives of a short term clean up (as the one presently under way) has been reached. This could therefore have an impact on the assurance of the functionality of the power station itself, as one of the priority of the clean up is to maintain the fulfilment of the quality threshold at the seawater intakes (cooling water).

Consequently, it could be necessary a deeper study of the area (especially tanks` area) in the framework of the clean up of the investigated industrial site.

Photo # 1

Photo # 2

Photo # 3

Photo # 4

Photo # 5

Photo # 6

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APPENDIX 6

"General recommendations for the characterization and recovery of Jieh power plant"

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Following the fire at Jieh power plant and the subsequent demolition activities, a constant release of oil to the sea is occurring.

Before starting the necessary clean-up and recovery of the polluted area of the power plant site, the following activities should be undertaken:

- delimitation of the vertical and horizontal extension of the contaminated area;
- localization of
  - active sources of contamination (pipes, underground tanks, etc.);
  - potential migration pathways of the contaminated plume; this aspect could be evaluated following a geological and hydro geological study of the area; from the information collected during the site visits the power plant seems to be built on a fractured calcareous bedrock;
  - target of the contamination (workers of the power plant, inhabitants of the surrounding villages, marine ecosystems, terrestrial ecosystems).
- interruption of the active pathways in order to avoid further diffusion of the contamination outside the affected area;
- safe storage of demolition waste;
- application of safety measures for human health protection (i.e. it should be advised against fishing from the rocks in the area of the intake; the workers of the plant should use personal protection devices).

To complete the above described activities samples of soil (top-soil, subsoil), groundwater, seawater, sediments should be taken and analysed. Furthermore the geological and hydro-geological information from field measures should be collected. The measured data could support the design of the appropriate remediation strategy.

The first activities shall focus on the containment of the leaking and migration towards the sea by the use of passive and/or active barriers (cement-bentonite walls, pump-and-treat, air-sparging barriers, biosparging barriers, permeable reactive barriers etc.). In a second moment the actions shall focus on the clean-up of the polluted soil through soil-washing, thermal desorption and other similar technologies, being dig-and-disposal the less desiderable option.

The results of the remediation activities over time shall be assessed by a monitoring plan.

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APPENDIX 7

'Fish sampling - basic protocol'

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a INFORMATION TO BE RECORDED

1) Fishing Date
2) Locality
3) Depth
4) Fishing Technique

b MODALITY OF PRESERVATION

1) insert the fish sample in the plastic envelop and write on the envelop the id, date and locality
2) preserve the fish sample at low temperature: –20 or –15 degrees Celsius

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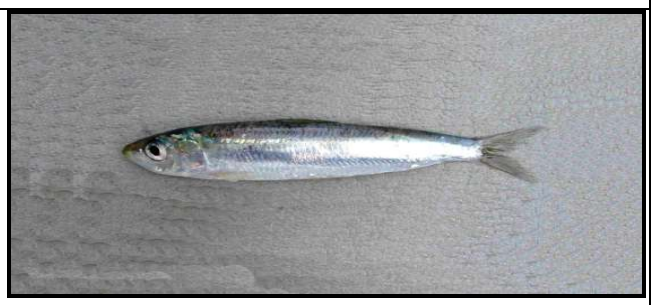
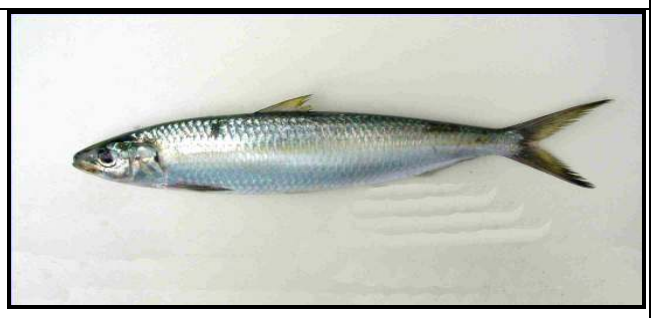
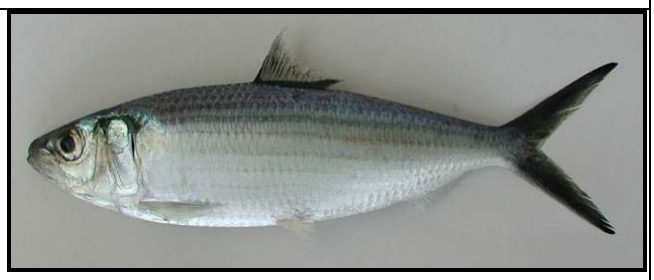
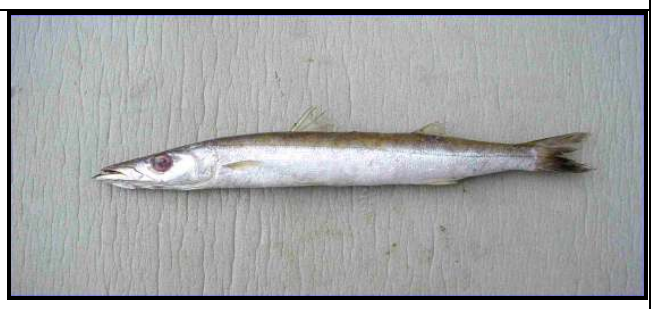
Nome scientifico *Sardina pilchardus* English name European pilchard Local name Sardyn Mabroum	
Nome scientifico *Sardinella aurita* English name Round sardinella Local name Latshyou	
Nome scientifico *Sardinella maderensis* English name Madeiran sradinella Local name Latshyou Kebir Lessepsiana	
Nome scientifico Sphyraena spp English name Barracuda Local name Lessepsiana	

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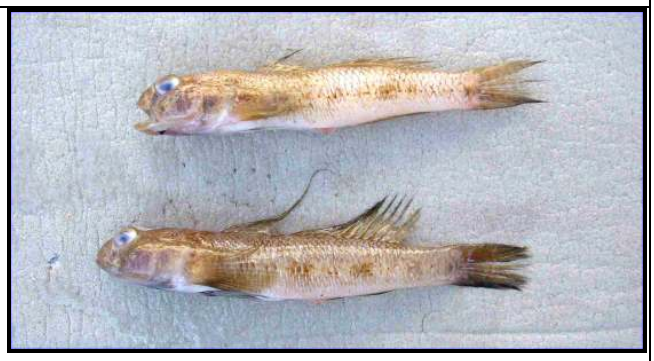
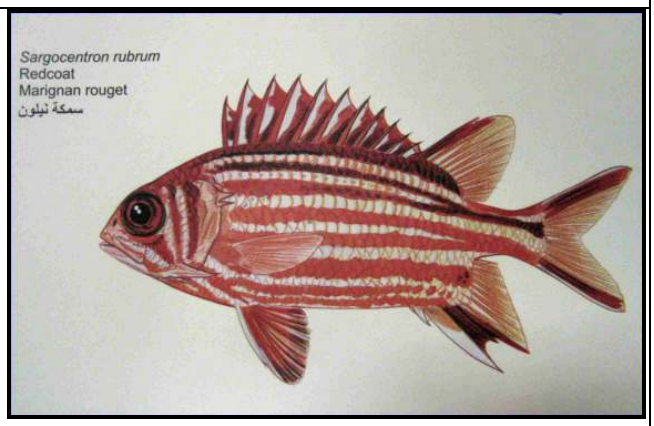
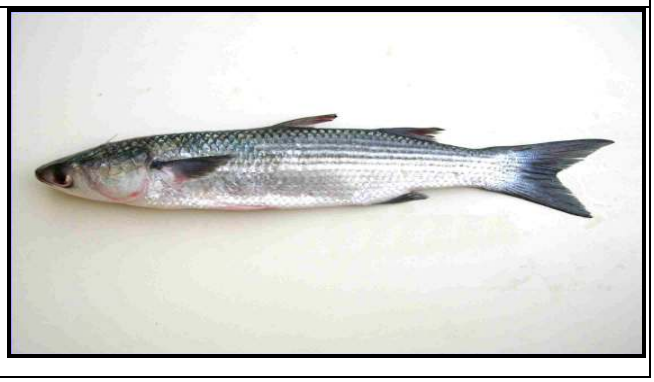
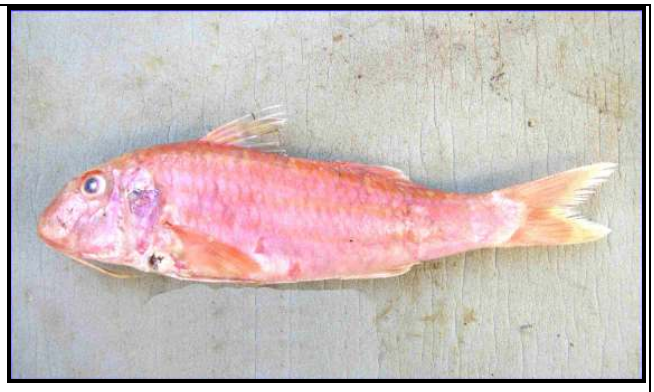
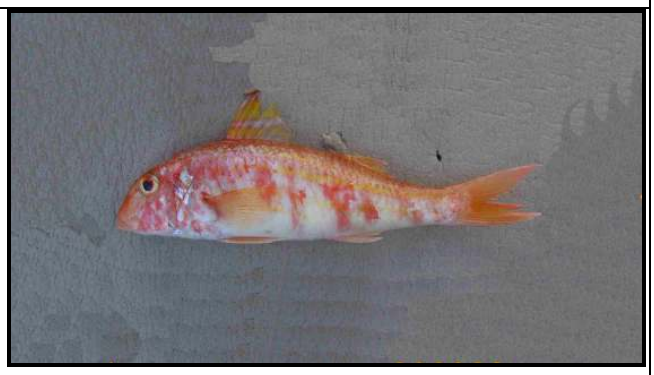
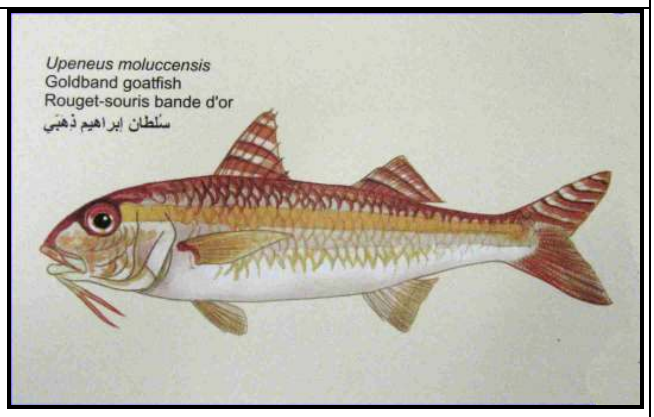
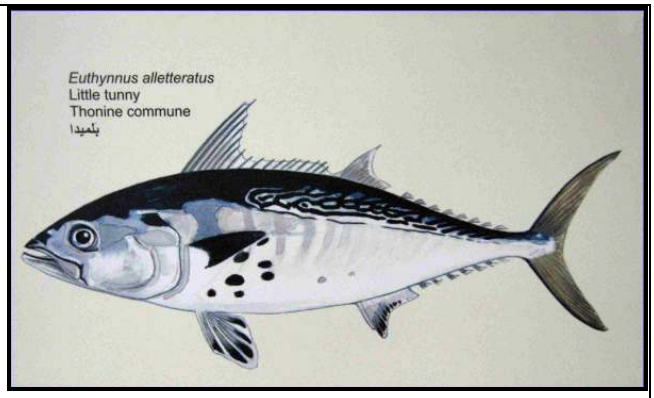
Nome scientifico *Gobius niger* English name Black goby Local name Kabboush	
Nome scientifico *Sargocentrum rubrum* English name Redcoat Local name Nayloun Lessepsiana	
Nome scientifico Liza spp. English name Mullet Local name Boury	

Nome scientifico *Mulis barbatu barbatus* English name Red mullet Local name Soultan Ibrahym Ramly	
Nome scientifico *Mullus surmuletus* English name Striped red mullet Local name Soultan Ibrahym Sakhry	
Nome scientifico *Upeneus moluccensis* English name Goldband goatfish Local name Soultan Yahoudy Lessepsiana	
Nome scientifico *Scarus ghobban* English name Blue-barred parrotfish Local name Lessepsiana	

Nome scientifico *Euthynnus alletteratus* English name Little tunny Local name Balamydah	
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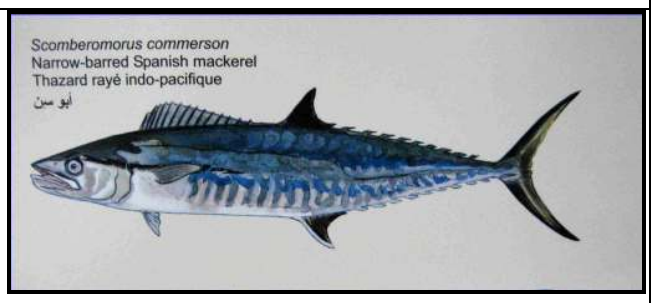
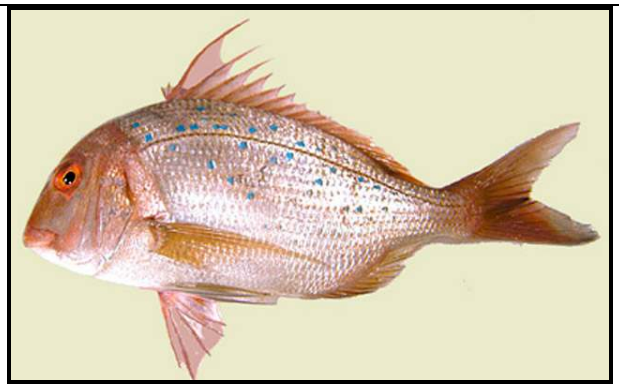
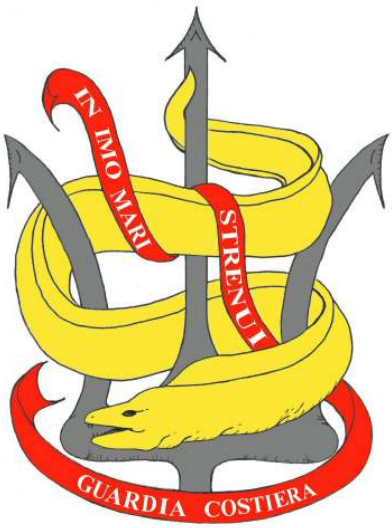
Nome scientifico *Scomberomorus commerson* English name Narrow-barred Spanish mackerel Local name Lessepsiana	
Nome scientifico *Siganus luridus* English name Duasky spinefoot Local name Mouasta Lessepsiana	

Nome scientifico *Siganus rivulatus* English name Marbled spinefoot Local name Mouasta Lessepsiana	
Nome scientifico *Boops boops* English name Bogue Local name Ghobbos	
Nome scientifico *Diplodus cervinus cervinus* English name Zebra seabrean Local name H'addad Dboulyeh	
Nome scientifico *Pagrus caeruleostictus* English name Bluespotted seabream Local name Farridy Lessepsiana	



ITALIAN COAST GUARD SHIP " ALFREDO PELUSO" CP 905
ITALIAN COAST GUARD DIVERS TEAM

REPORT ON THE ACTIVITIES
JIEH SEPTEMBER 21 – OCTOBER 14

INTRODUCTION

The main task of the ITCG Ship and Divers inside the operation “Bahar” has been to coordinate the operations at sea and make the preliminary survey and the assessment of the Jieh site.

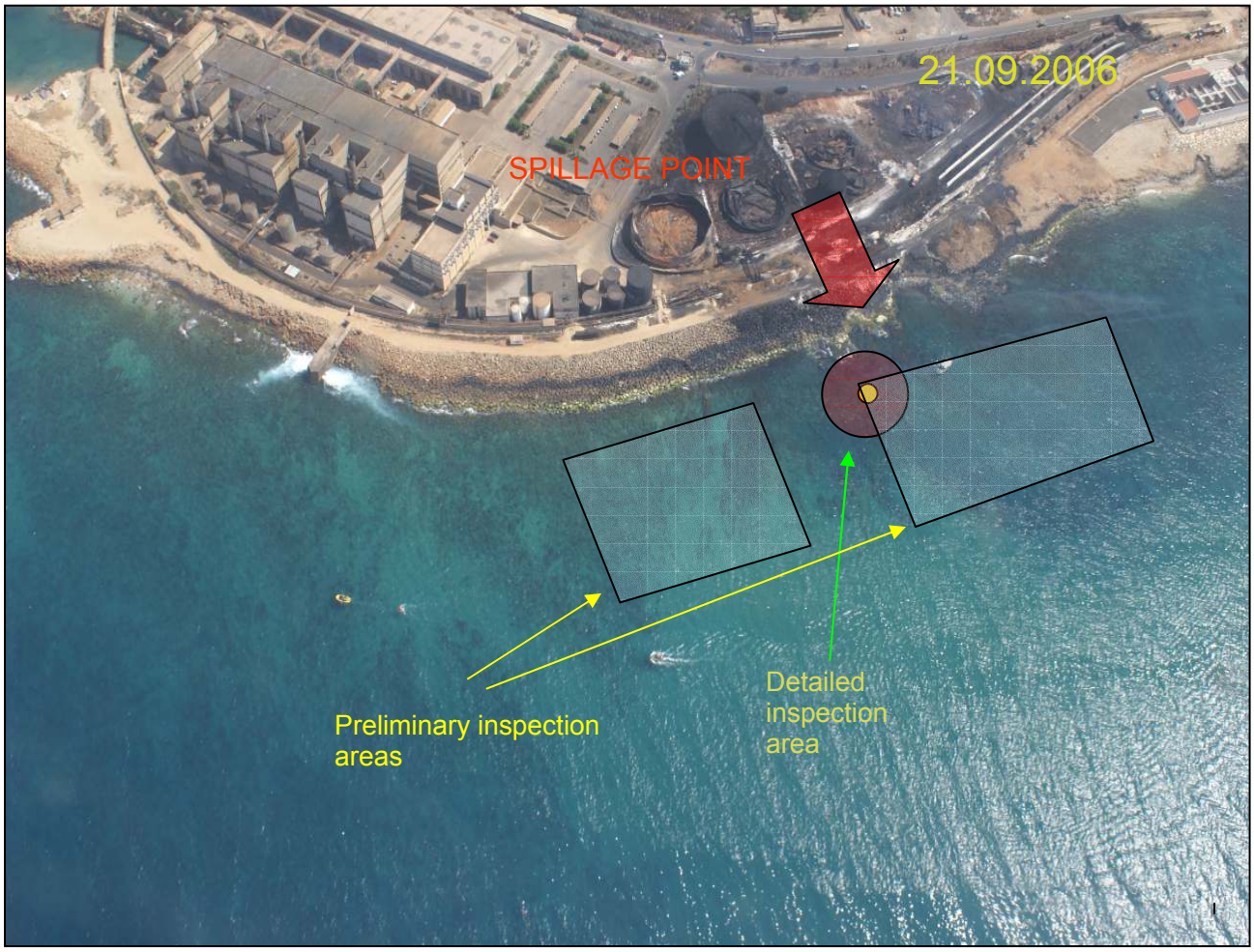
The diver’s team, composed of five divers, has been embarked on the Coast Guard ship “Peluso” in order to have the necessary technical and safety support.

The technical equipment consists of:

- One surface supplied diving equipment for polluted - waters diving which allows two divers to operate contemporarily;
- Underwater video/photographic equipment;
- One ROV (Remote Operated Vehicle) for unmanned underwater surveys;
- 3 underwater recovery balloons (up to one ton);
- Water suction pump.;
- Dispersants;
- Two rubber boats.

OPERATION'S CHRONOLOGY

21.09 2006



Surface recognition of the area in order to verify the general conditions of the site with a particular attention to:

- Coast configuration;
- Surface currents.

Five dives to determine the sea bottom geomorphology.

The results of this first day of work are the following:

- The sunken polluting product is present on the sea bottom in large amounts;
- The pollution patches are mostly covered by a sand layer that makes ineffective the bare visual recognition, thus requesting a close look of every single sand floor;

- The oil has practically occupied every possible space between the rocks (see figure 1) and the irregular shape of the oil patches does not permit an estimate of the volume of the pollutant.

An intense surf did not permit the recognition in the area close to the shoreline.

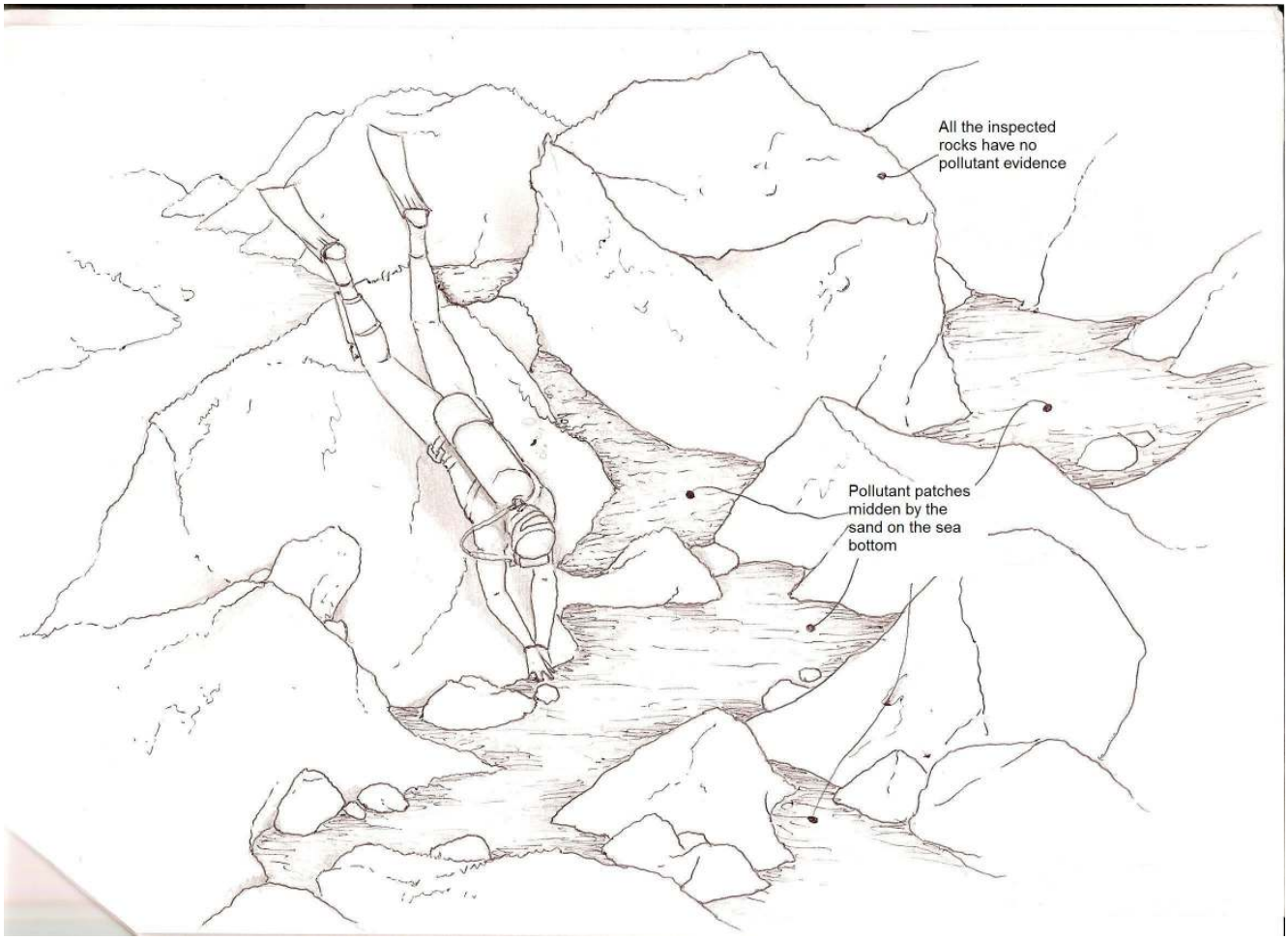


Figure 1

22.09.2006

The persisting surf prevented the inspection of the area close to the shoreline and the operations have been moved to an area close to the spilling point.

The visual and “touch” controls operated during the day evidenced the following:

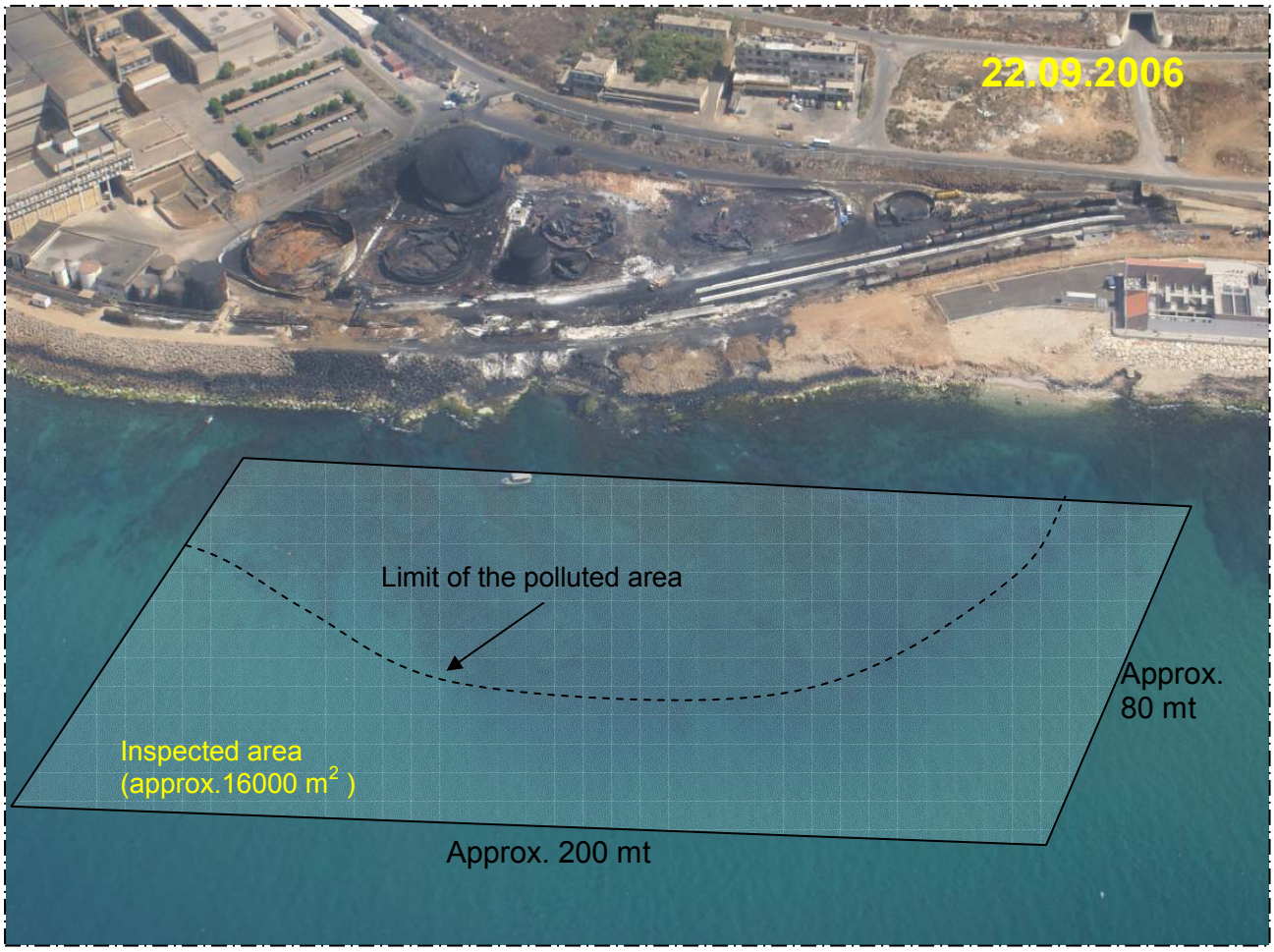
- The sea bottom in front of blown- off tanks is characterized by degrading rocks bordered on the north, south and west by large sand patches;
- In the sand bottom between the rocks the pollutant appears to be present on a scattered basis;
- The pollutant has been found prevalently in the solid and semi-solid appearance (see pictures).

Solid appearance pollutant

Semi – solid appearance pollutant

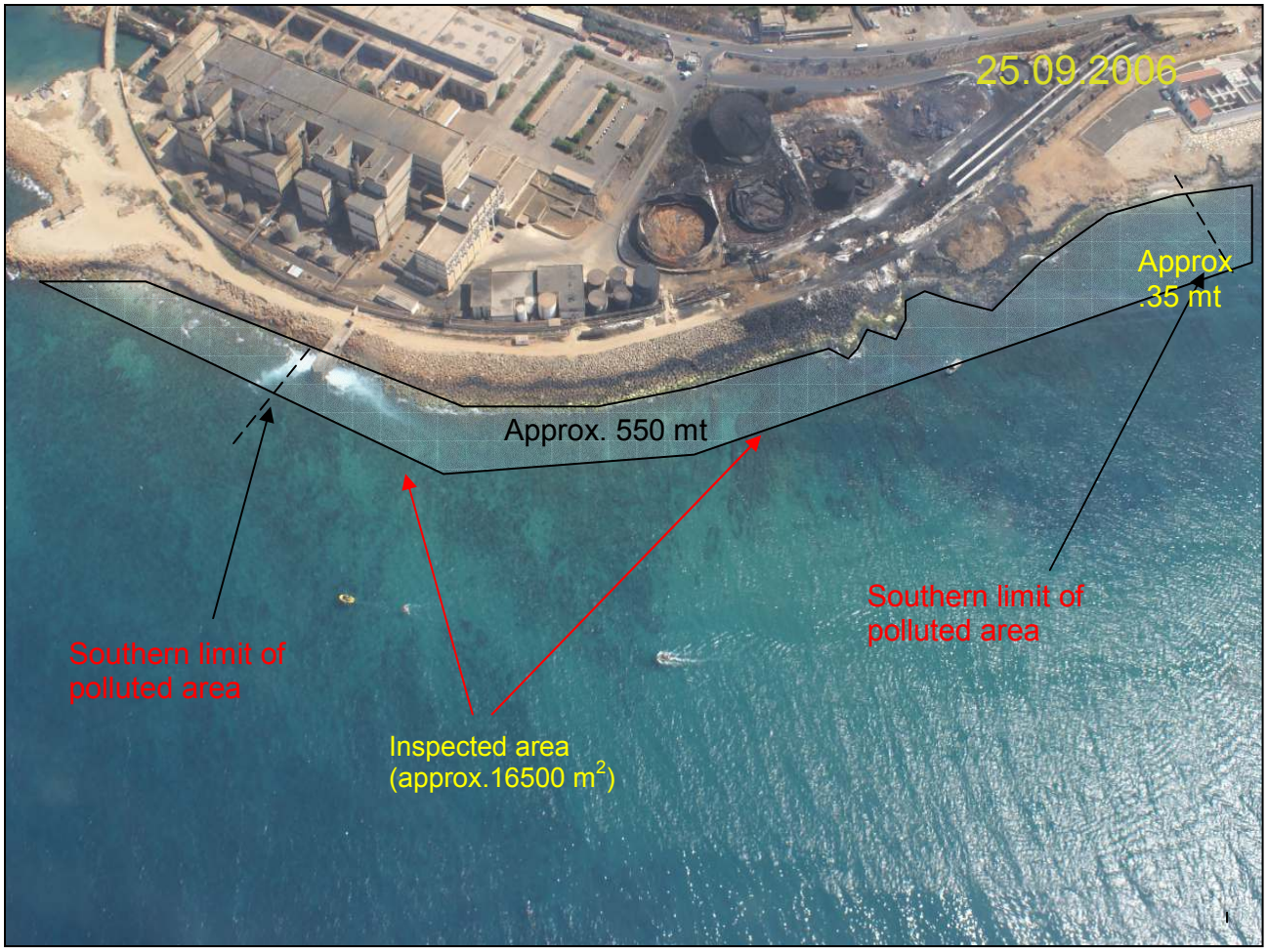
- In the southern peripheral rocky area there is evidence of reduction of the presence of the pollutant whom amount, in the northern and western areas, is almost constant.

  The observations give evidence that the evolution of the sunken pollutant has, basically, followed the north oriented shape progression of the floating patch



25.09.2006

Tanks to the perfect meteorological and sea conditions the survey has been concentrated in the strip close to the shore.



The visual and “touch” controls operated during the day evidenced the following situation:

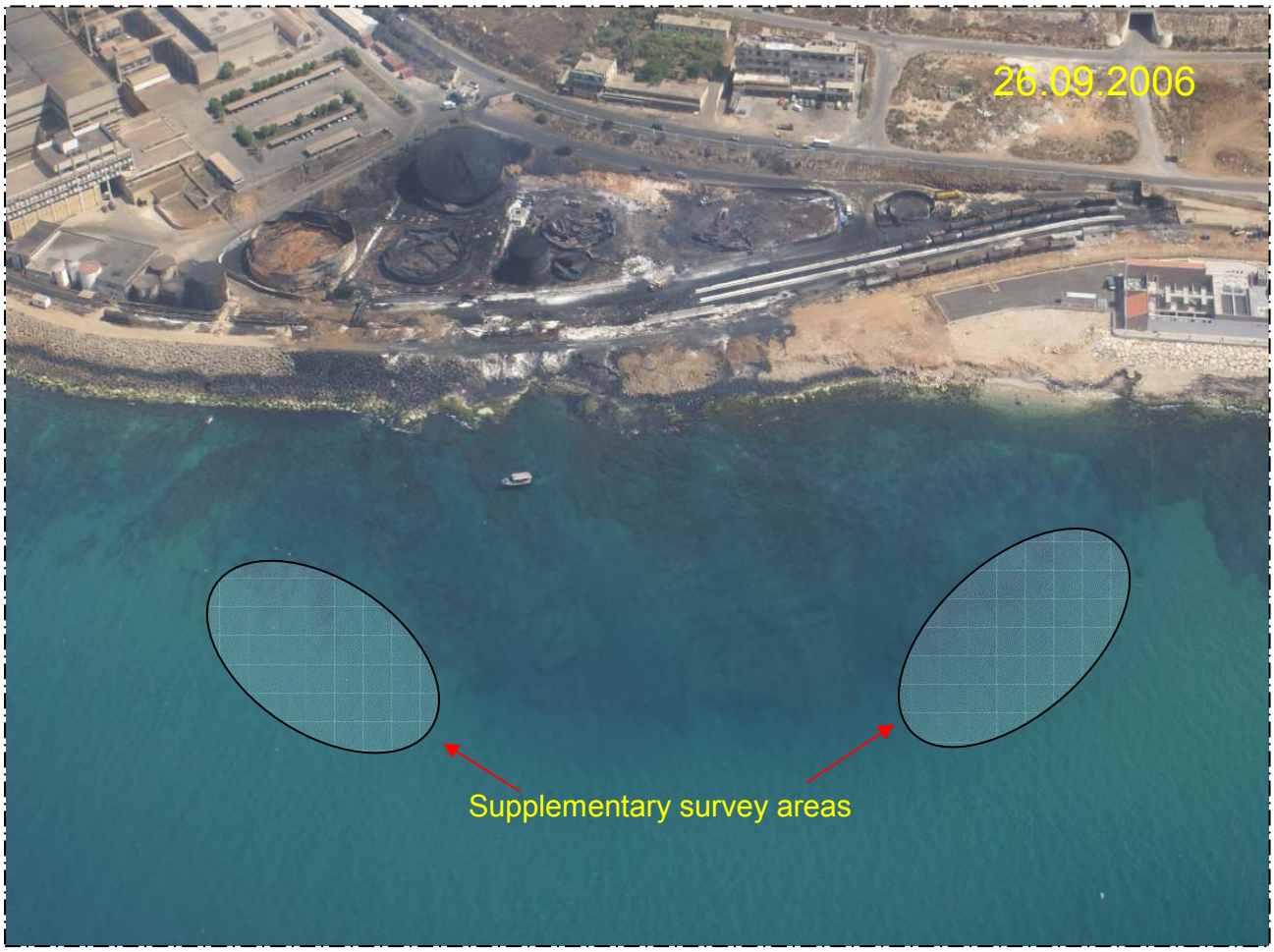
- On the sea bottom, in front of the spillage point, there is the higher concentration of pollutant;
- The pollutant concentration decrease progressively northbound and southbound from the tank area close to the coast;
- As noted during the first dive large patches of pollutant is hidden by a sand layer in almost every space between the rocks.

Pollutant trapped between the rocks

26.10.2006

The activities of the day have been dedicated to an accurate survey of the sand patches on the northern, southern and western border of the rocky area in front of the site.

The survey, performed with the usual visual – touch technique, with the addition of some randomic digging to a depth of approximately 40 centimeters of the sea bottom, has evidenced the absence of pollutants in the inspected area.

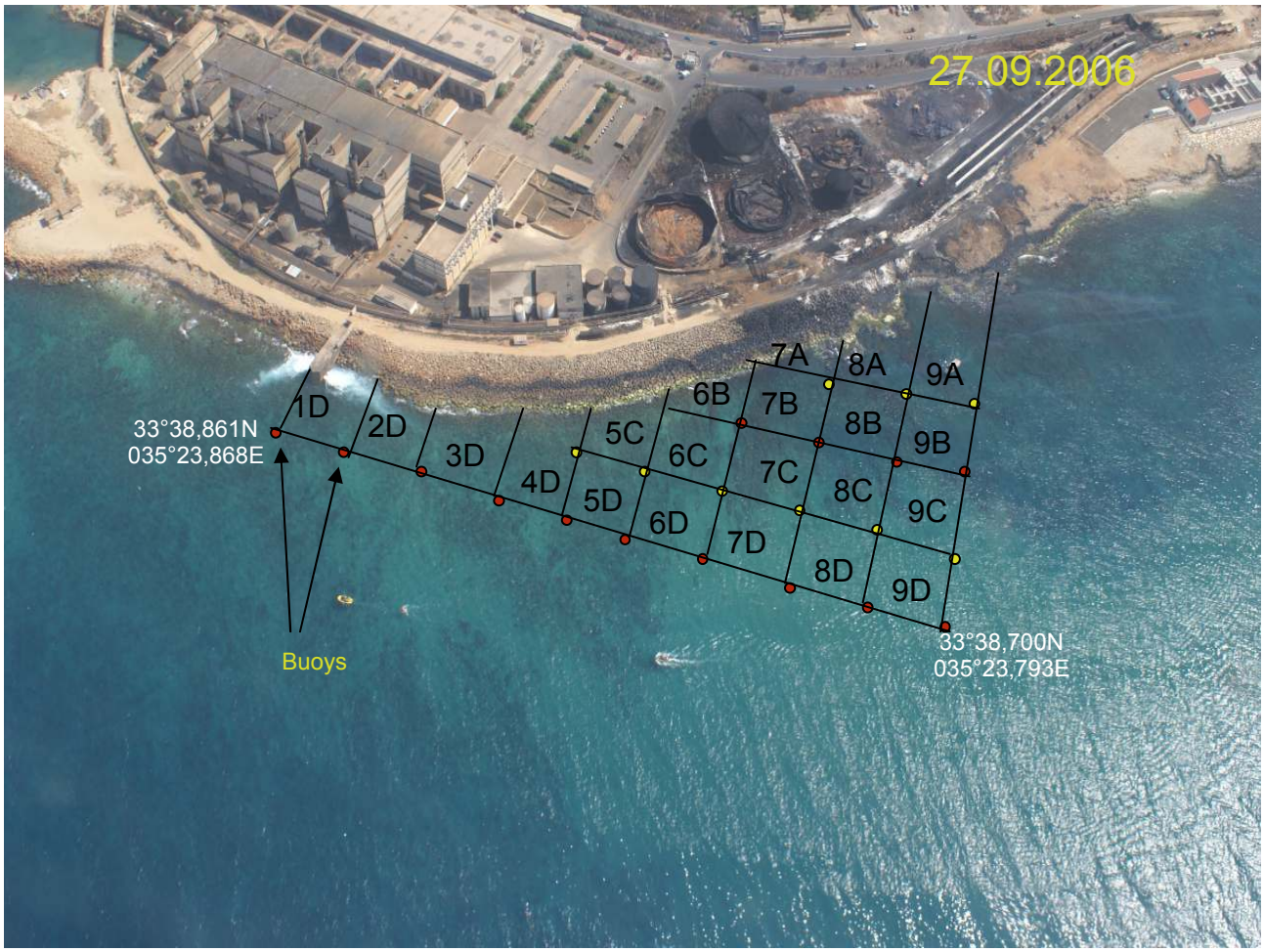


27.09.2006

The day has been dedicated to the positioning of a reference grid, marked with floating buoys, in cooperation with Castalia.

The purpose of the grid is to divide the area in small portions in order to systematically progress in the assessment and recovery operations.

21 sub areas of 30 X 30 meters have been positioned between the exhaust of the power plant and the spilling point.



28.09.2006

In order to accurately plan the pollutant recovery operations, during the day has been performed the assessment of each square of the grid.

This survey permitted, for each single square, to collect the following data:

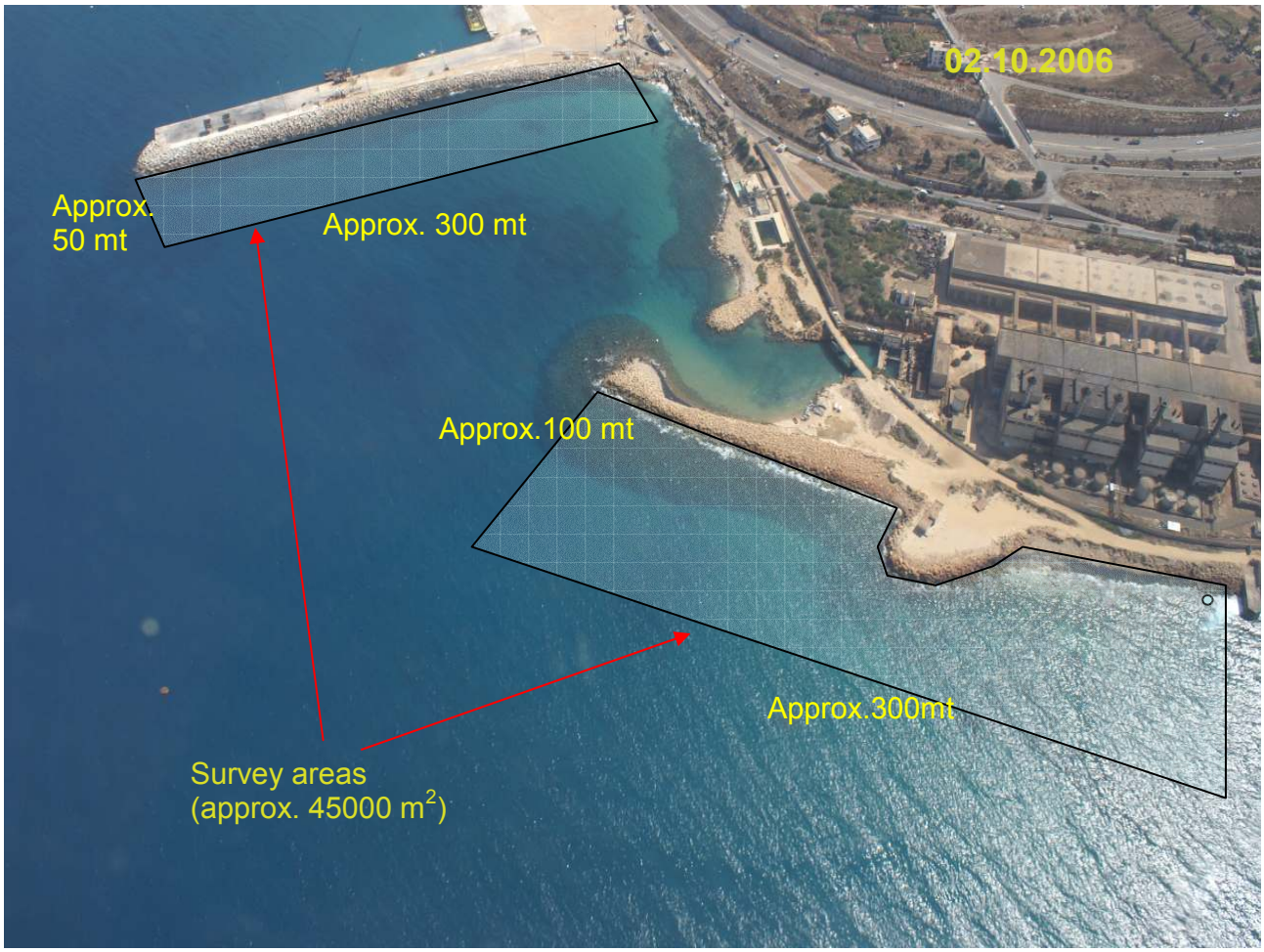
- Sea bottom geomorphology;
- Average depth;
- Pollutant concentration;
- Pollutant characteristics.

During the survey, since the amount of pollutant found in a rocky area placed immediately after the border of the grid, it has been decided to expand the grid area towards the open sea.

02.10.2006

Having completed the assessment of the pollution in the area close to the spilling point, it has been decided to survey the sea bottom in the northern part close to the Jieh plant.

The survey, located on the coast area between the exhaust and the plant piers, permitted to verify that the pollution is very poor in the area and, since the sea bottom is mostly sandy, it appears to be necessary more accurate investigation techniques.

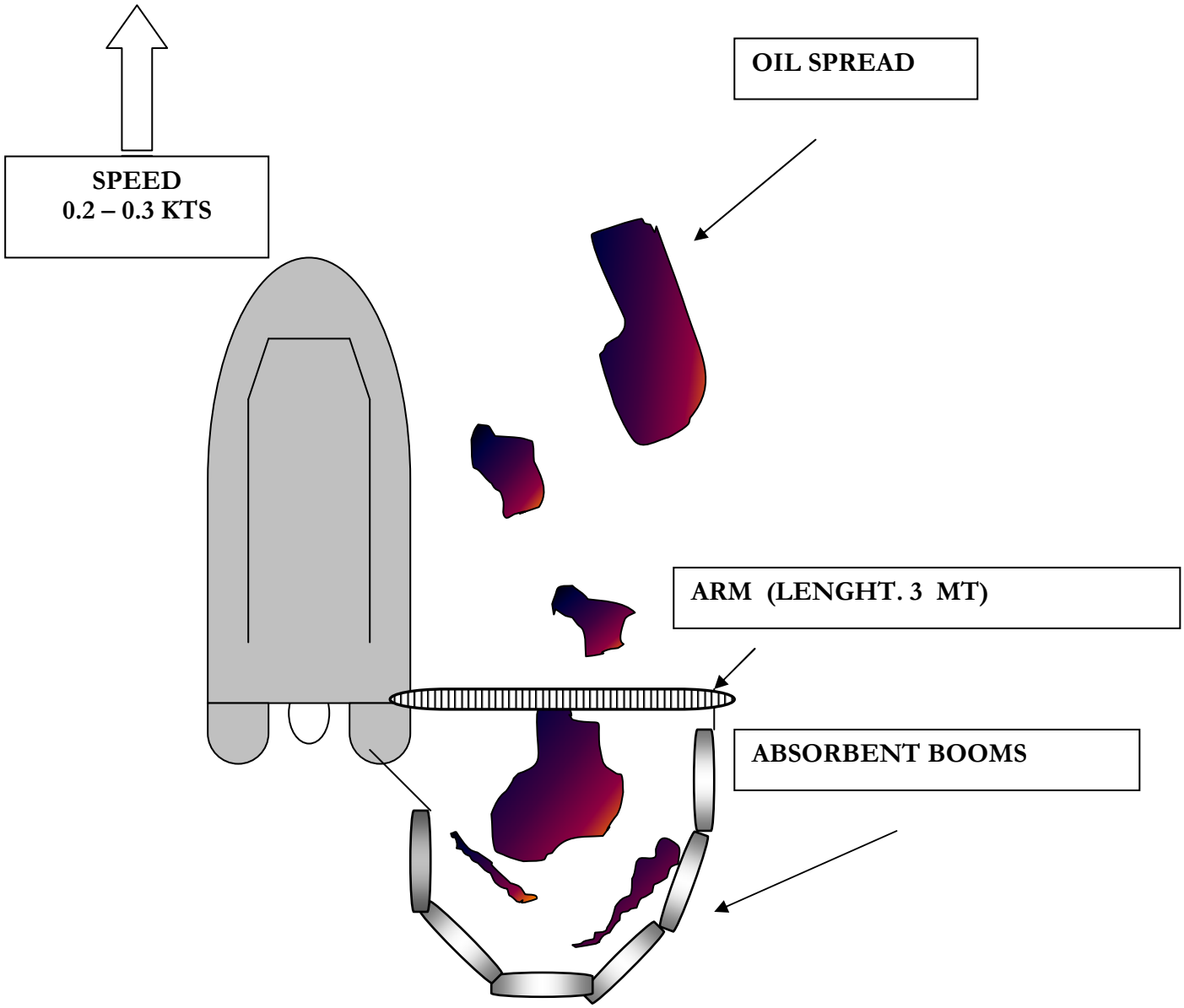


During the survey samples of biological materials have been collected for scientific analysis.

It has been noted a kind of partial “melting” process of the pollutant, meaning that from the amount of product on the sea bottom some oil bubbles rise to the surface producing the iridescence often found on the sea surface.

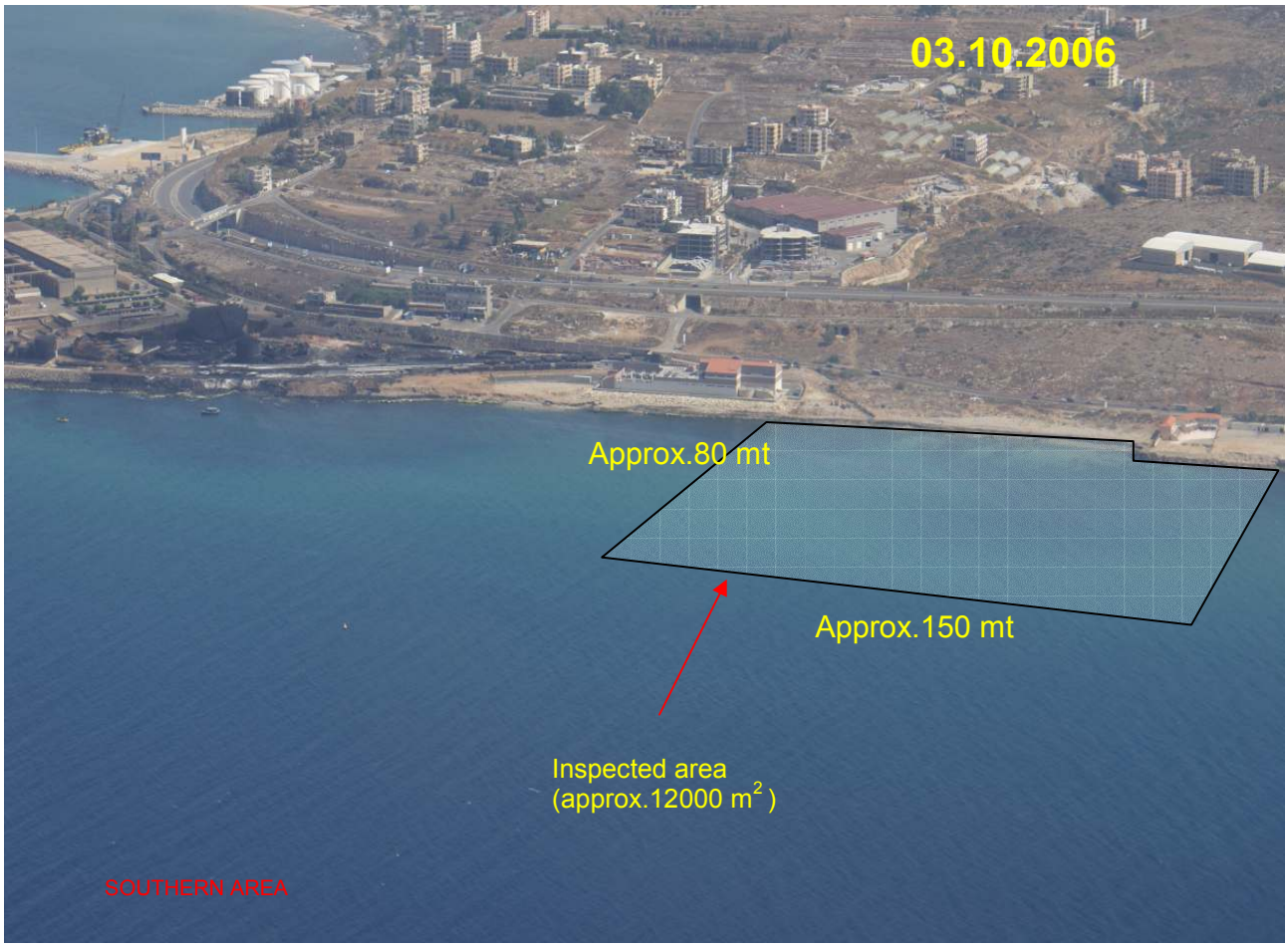
Oil bubbles (about 5cm in diameter) observed in a pollutant agglomerate partially covered by sand.

The “Peluso” Ship has performed, during the day, an antipollution operation in position 33°43’N 035°23’E employing absorbent booms and rubber dinghyes



03.10.2006

The surveys have been extended to the areas south and north of the power plant and apparently no evidence of pollutant has been found.

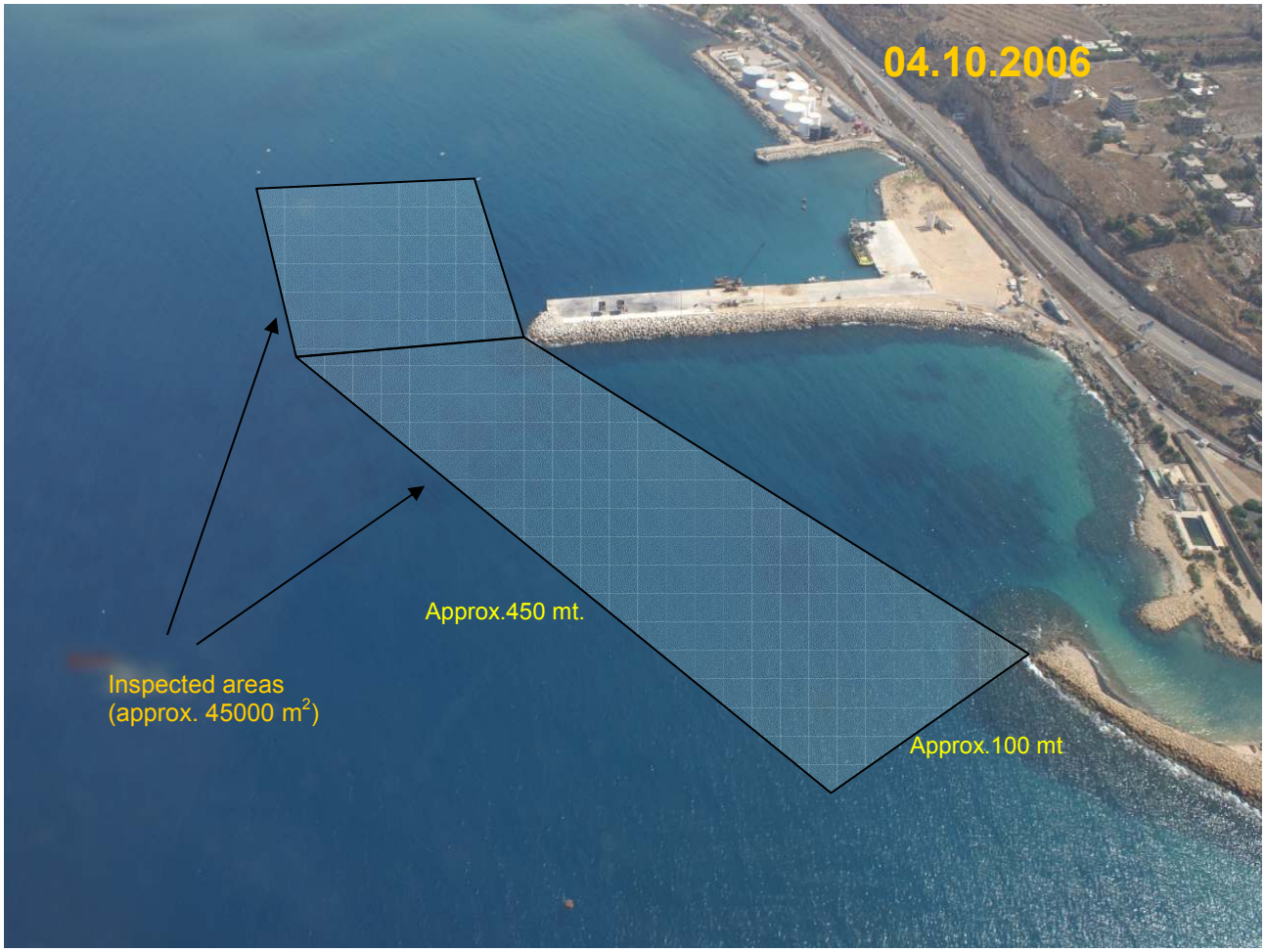



03.10.2006
Approx. 200mt
Approx. 40 mt
Inspected area
(approx. 8000 m2)
NORTHERN AREA (SABLINE TANK AREA)

04.10.2006

Survey operations continue to take place in the surroundings of Jieh power plant, the recognition has been extended to the area near the cooling water intake. Also in this area the amount of dense pollutant in negligible.

At the end of the recognition dives have been placed four buoys along the southern borders of the area in order to identify the area where the new grid will be located.

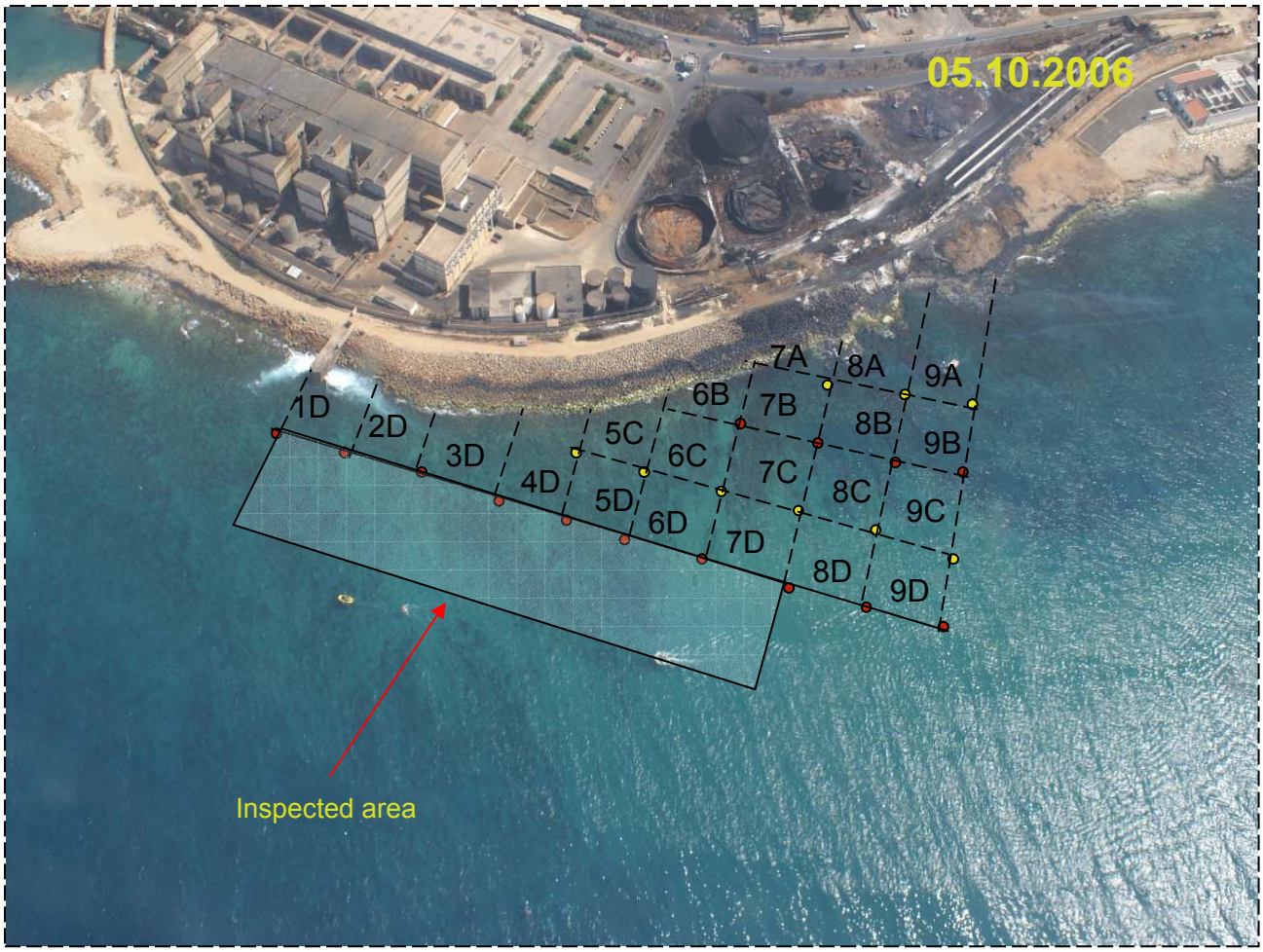


During the day The “Peluso” has carried out antipollution operation two nautical iles west of Jieh power plant using 15 meters of absorbent booms

05.10.06

With regard to the analysis of the results of September 28 dive (that suggested to extend the grid toward the open sea) a survey dive is performed west of the more external squares of the grid.

The recognition result is that there is a limited amount of pollutant on the sea bottom facing squares 1D to 7D, confirming the need of a further extension of the area to be cleaned.



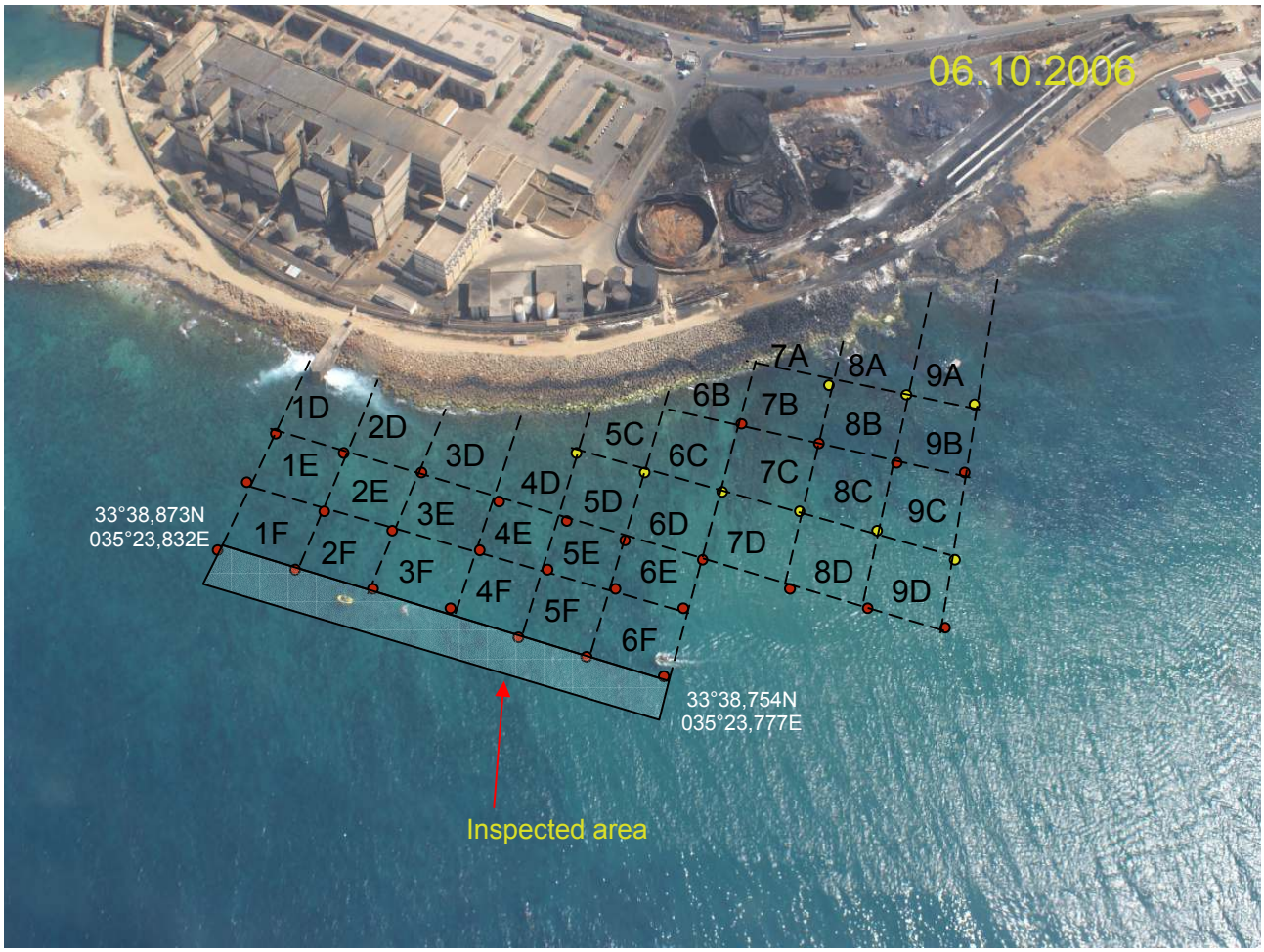
06.10.06

As planned the previous day, a new “buoy field” is located west of the original one facing squares 1D to 6D south of the Jieh plant exhaust.

Twelve new cleaning areas are then determined by the positioning of 14 buoys.

At the end of the positioning operations a new survey has been carried further westbound to the open sea.

The survey, even if summary, has evidenced more polluted material and lend to the need of more accurate surveys of the area.



09.10.06

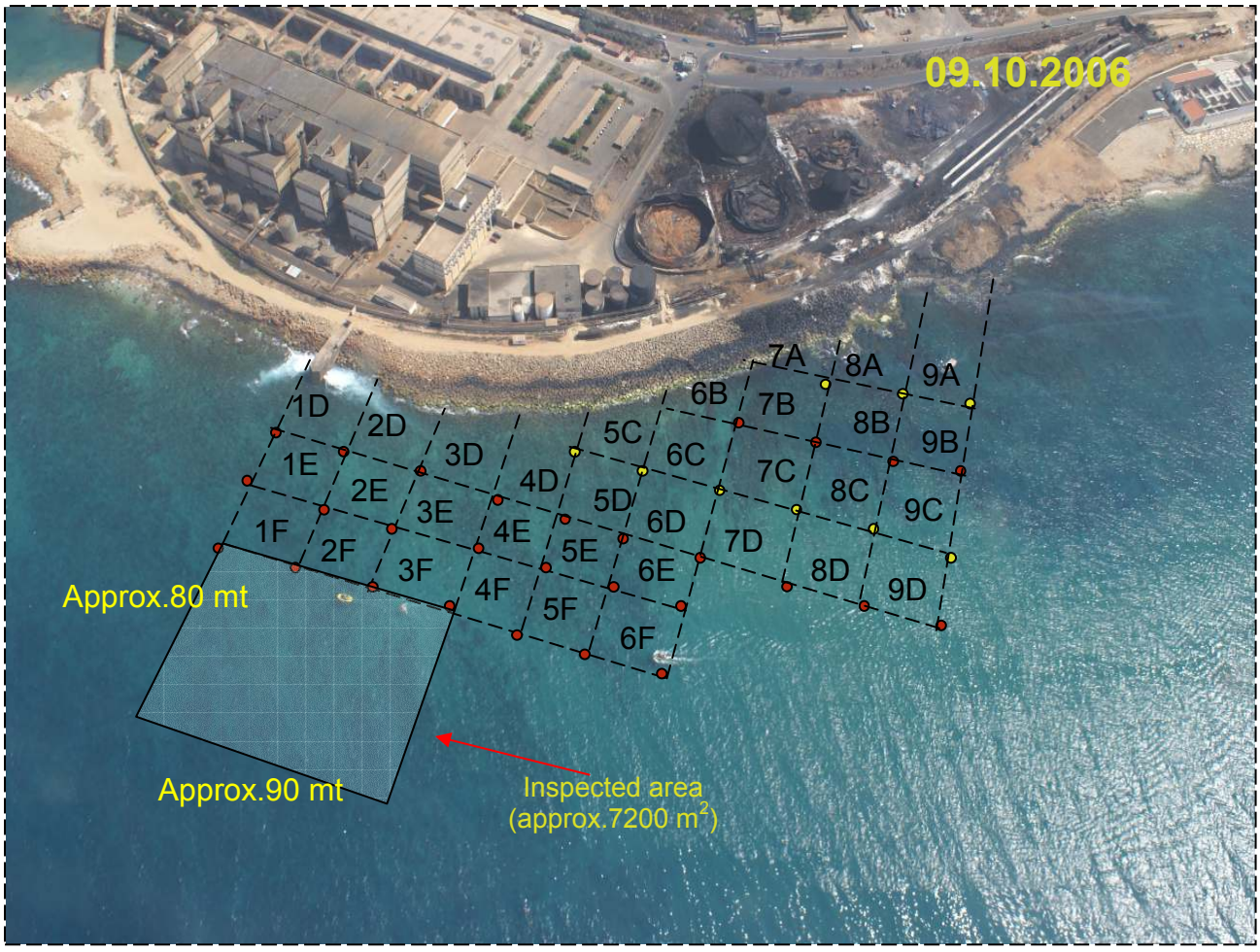
The characterization of the squares put in place on the 6th has been performed.

This survey permitted, for each of the 12 squares, to collect the following data:

- Sea bottom geomorphology;
- Average depth;
- Pollutant concentration;
- Pollutant characteristics.

The collected data has been employed to plan the cleaning operations.

A survey is then carried on in the area facing the square 1F to 3F to check the presence of pollutant. Minor quantities are found.



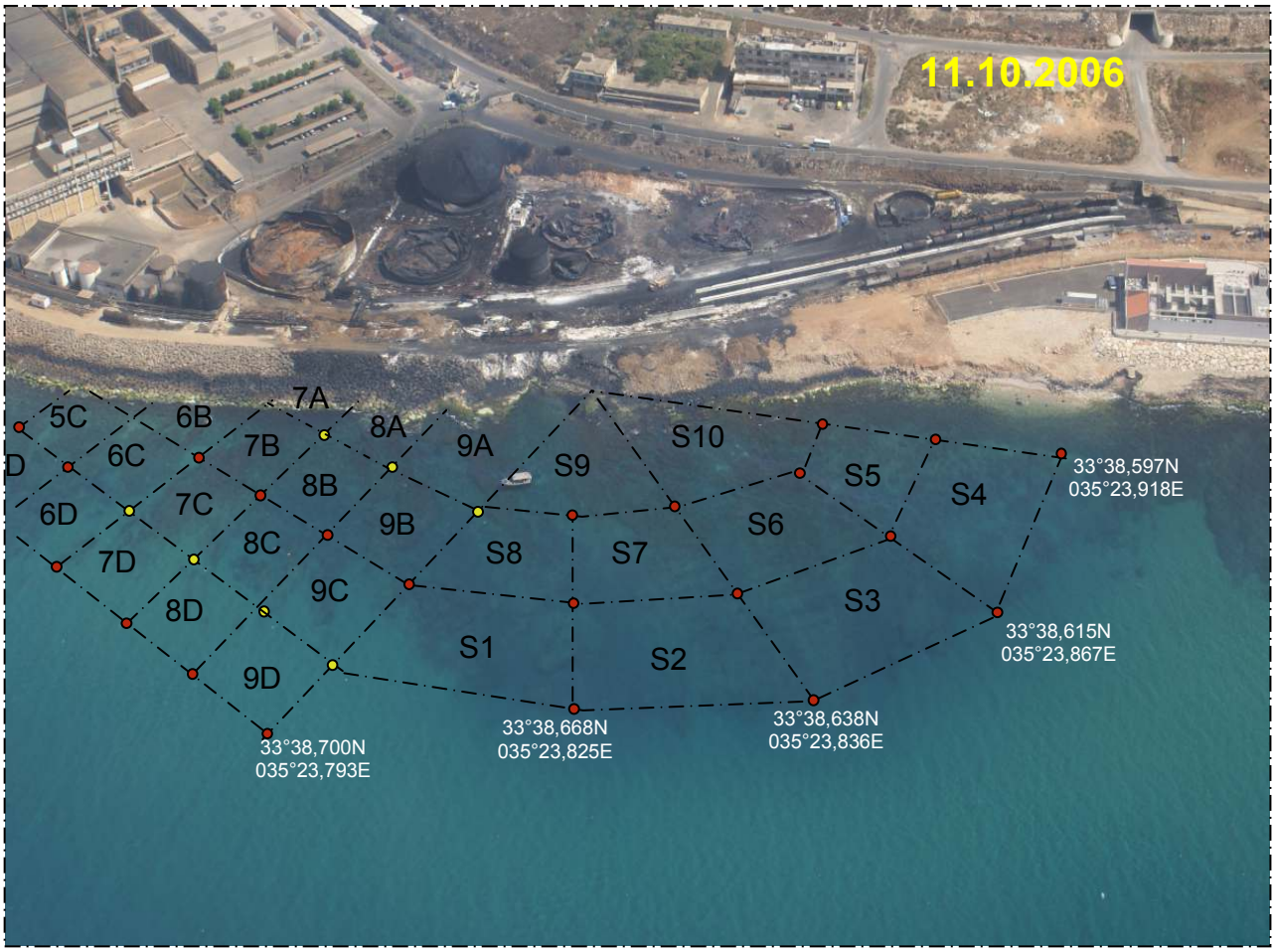
10.10.2006

During the transfer navigation from Beirut harbour to Jieh operational area, the ship has been diverted to a polluted area north of Beirut.

Two oil slicks have been located and removed with absorbent booms.

11.10.06

The grid has been placed over the entire polluted area. The southern part of the area has been divided using a sector scheme. Ten more areas are then determined.



12.10.06

Survey dive in the new12 squares, to collect the following data:

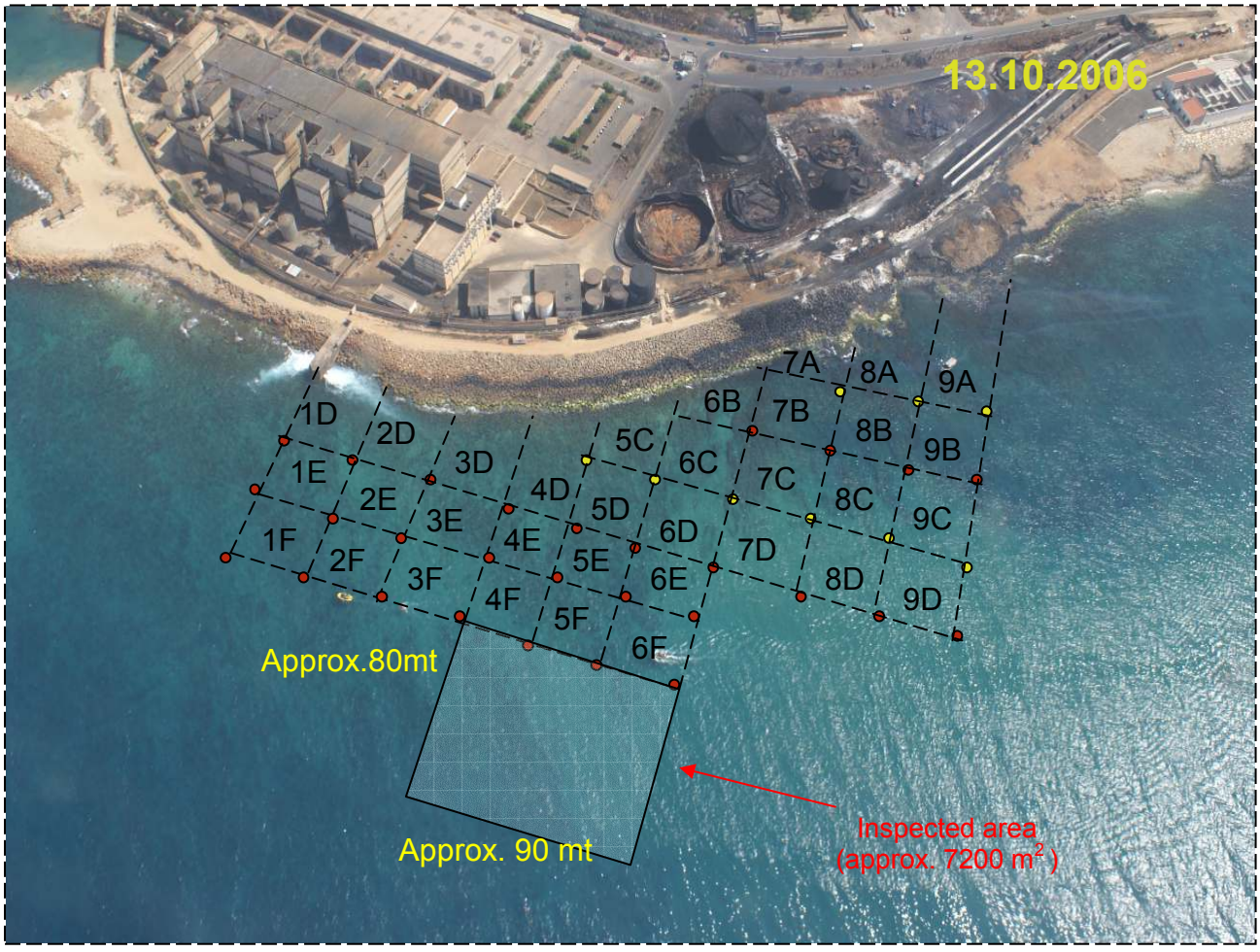
- Sea bottom geomorphology;
- Average depth;
- Pollutant concentration;
- Pollutant characteristics.

13.10.06

The Coast Guard divers have been employed to support Italian scientific personnel of the Italian delegation at O.S.O.C.C. in order to collect video documentation and pollutant evidence in the area west of squares 4F to 6F.

The monitoring has evidenced a consistent quantity of pollutant in the area facing square 6F (in the rest of the area the pollutant is scattered) and so forth the need of adding a new square to the grid.

At the end of underwater operations, surface oil cleaning operations are performed by ITCGS “Peluso” with is own antipollution equipment.

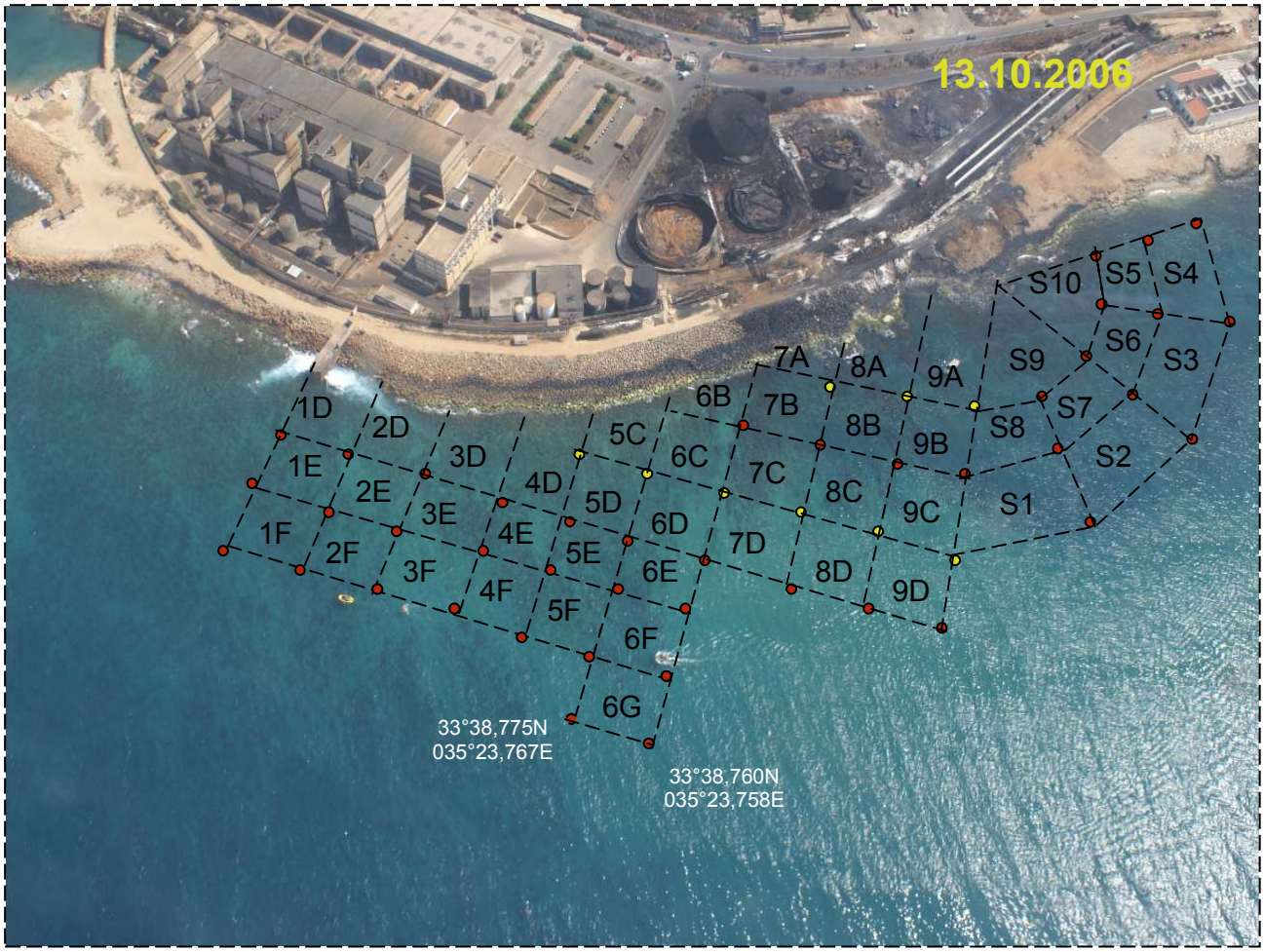


14.10.06

The day has been used top put in place the reference points for the last square (6G).

Due to the activity of Castalia it has been decided to mark the square limits with sea bottom markers instead of buoys (the advantage is that they are not bothering ship movements).

Characterization data of the square is then collected.



CONCLUSIONS

At the end of this first operating cycle, lasted 15 working days, the Coast Guard divers has performed, in the area facing the Jieh power plant, the monitoring of approximately 206.900 square meters of sea bottom of which approximately 50.000 square meters appear to be polluted.

All the polluted areas have been marked with the positioning of 51 buoys determining 44 squares of different shapes and extension.

For every square characterization data have been collected in order to plan the cleaning operations.

The data have been given to Castalia.

Characterization data of the grid squares in the sea bottom facing Jieh power plant

NOTE: the "pollutant concentration" voice is intended:
- **High** – pollutant in every single crevice;
- **Medium - presence** of pollutant in more then the half of the controlled crevices;
- **Low -** presence of pollutant in less then the half of the controlled crevices;

1-D

Average depth:	3 meters
Sea bottom geomorphology:	mainly rocky
Pollutant consistence:	mainly semisolid
Pollutant concentration:	low

2-D

Average depth:	3 - 4 meters
Sea bottom geomorphology:	mainly sandy
Pollutant consistence:	//
Pollutant concentration:	negative

3-D

Average depth:	3 - 4 meters
Sea bottom geomorphology:	mainly rocky
Pollutant consistence:	mainly semisolid
Pollutant concentration:	low

4-D

Average depth:	4 meters
Sea bottom geomorphology:	mainly rocky
Pollutant consistence:	mainly solid
Pollutant concentration:	low

5-D

Average depth:	3.5 meters
Sea bottom geomorphology:	mainly rocky
Pollutant consistence:	mainly semisolid
Pollutant concentration:	medium

6-D

Average depth:	5 meters
Sea bottom geomorphology:	mixed sand/rocks
Pollutant consistence:	mainly solid
Pollutant concentration:	low

7-D

Average depth:	4 meters
Sea bottom geomorphology:	mixed sand/rocks
Pollutant consistence:	mainly semisolid
Pollutant concentration:	low

8-D

Average depth:	5 meters
Sea bottom geomorphology:	mainly sandy
Pollutant consistence:	//
Pollutant concentration:	negative

9-D

Average depth:	5.5 meters
Sea bottom geomorphology:	mainly sandy
Pollutant consistence:	//
Pollutant concentration:	negative

5-C

Average depth:	3.5 meters
Sea bottom geomorphology:	mainly rocky
Pollutant consistence:	mainly semisolid
Pollutant concentration:	medium

6-C

Average depth:	5 meters
Sea bottom geomorphology:	mainly rocky
Pollutant consistence:	mainly semisolid mainly rocky
Pollutant concentration:	low

7-C

Average depth:	4 meters
Sea bottom geomorphology:	mixed sand/rocks
Pollutant consistence:	mainly semisolid
Pollutant concentration:	medium

8-C

Average depth:	3 meters
Sea bottom geomorphology:	mainly rocky
Pollutant consistence:	mixed solid/semi liquid
Pollutant concentration:	medium-high

9-C

Average depth:	5 meters
Sea bottom geomorphology:	mainly sandy
Pollutant consistence:	mainly semi liquid
Pollutant concentration:	medium

6-B

Average depth:	3 meters
Sea bottom geomorphology:	mainly rocky
Pollutant consistence:	mainly solid
Pollutant concentration:	medium

7-B

Average depth:	4 meters
Sea bottom geomorphology:	mainly rocky
Pollutant consistence:	mainly rocky
Pollutant concentration:	high

8-B

Average depth:	4 meters
Sea bottom geomorphology:	mainly rocky
Pollutant consistence:	mixed solid/semi liquid
Pollutant concentration:	high

9-B

Average depth:	3 meters
Sea bottom geomorphology:	mainly rocky
Pollutant consistence:	mainly solid
Pollutant concentration:	medium

7-A

Average depth:	3 meters
Sea bottom geomorphology:	mainly rocky
Pollutant consistence:	mainly semisolid
Pollutant concentration:	high

8-A

Average depth:	2 meters
Sea bottom geomorphology:	mainly rocky
Pollutant consistence:	mainly semisolid
Pollutant concentration:	high

9-A

Average depth:	3 meters
Sea bottom geomorphology:	mainly rocky
Pollutant consistence:	mainly semisolid
Pollutant concentration:	high

1-E

Average depth:	4 meters
Sea bottom geomorphology:	mainly rocky
Pollutant consistence:	mainly solid
Pollutant concentration:	low

2-E

Average depth:	4 meters
Sea bottom geomorphology:	mixed sandy/rocky
Pollutant consistence:	mixed solid/semi liquid
Pollutant concentration:	low

3-E

Average depth:	4,5 meters
Sea bottom geomorphology:	mixed sandy/rocky
Pollutant consistence:	mainly semi liquid
Pollutant concentration:	low - negative

4-E

Average depth:	4 meters
Sea bottom geomorphology:	mainly rocky
Pollutant consistence:	mainly semi liquid
Pollutant concentration:	medium

5-E

Average depth:	4 meters
Sea bottom geomorphology:	mainly rocky
Pollutant consistence:	mainly semi liquid
Pollutant concentration:	medium

6-E

Average depth:	5 meters
Sea bottom geomorphology:	mixed sandy/rocky
Pollutant consistence:	mainly semi liquid
Pollutant concentration:	medium

1-F

Average depth:	5 meters
Sea bottom geomorphology:	mainly rocky
Pollutant consistence:	mainly semisolid
Pollutant concentration:	very low

2-F

Average depth:	4,5 meters
Sea bottom geomorphology:	mainly rocky
Pollutant consistence:	mostly semi liquid
Pollutant concentration:	very low

3-F

Average depth:	4 meters
Sea bottom geomorphology:	mainly sandy
Pollutant consistence:	mainly semi liquid
Pollutant concentration:	medium - low

4-F

Average depth:	4,5 meters
Sea bottom geomorphology:	mixed sandy/rocky
Pollutant consistence:	mainly semi liquid
Pollutant concentration:	medium

5-F

Average depth:	5 meters
Sea bottom geomorphology:	mixed sandy/rocky
Pollutant consistence:	mainly semi liquid
Pollutant concentration:	medium - low

6-F

Average depth:	6 meters
Sea bottom geomorphology:	mixed sandy/rocky
Pollutant consistence:	mainly semi liquid
Pollutant concentration:	medium

6-G

Average depth:	8.5 meters
Sea bottom geomorphology:	mixed sandy/rocky
Pollutant consistence:	mainly semi liquid
Pollutant concentration:	low

S-1

Average depth:	7 meters
Sea bottom geomorphology:	mainly rocky
Pollutant consistence:	mainly solid
Pollutant concentration:	high

S-2

Average depth:	7 meters
Sea bottom geomorphology:	mainly rocky
Pollutant consistence:	mainly solid
Pollutant concentration:	high

S-3

Average depth:	5 meters
Sea bottom geomorphology:	mainly rocky
Pollutant consistence:	mainly solid
Pollutant concentration:	high

S-4

Average depth:	4 meters
Sea bottom geomorphology:	mixed sandy/rocky
Pollutant consistence:	mainly semisolid
Pollutant concentration:	high

S-5

Average depth:	3 meters
Sea bottom geomorphology:	mainly rocky
Pollutant consistence:	mainly semisolid
Pollutant concentration:	high

S-6

Average depth:	6 meters
Sea bottom geomorphology:	mainly rocky
Pollutant consistence:	mainly solid
Pollutant concentration:	medium - high

S-7

Average depth:	5,5 meters
Sea bottom geomorphology:	mainly rocky
Pollutant consistence:	mainly solid
Pollutant concentration:	high

S-8

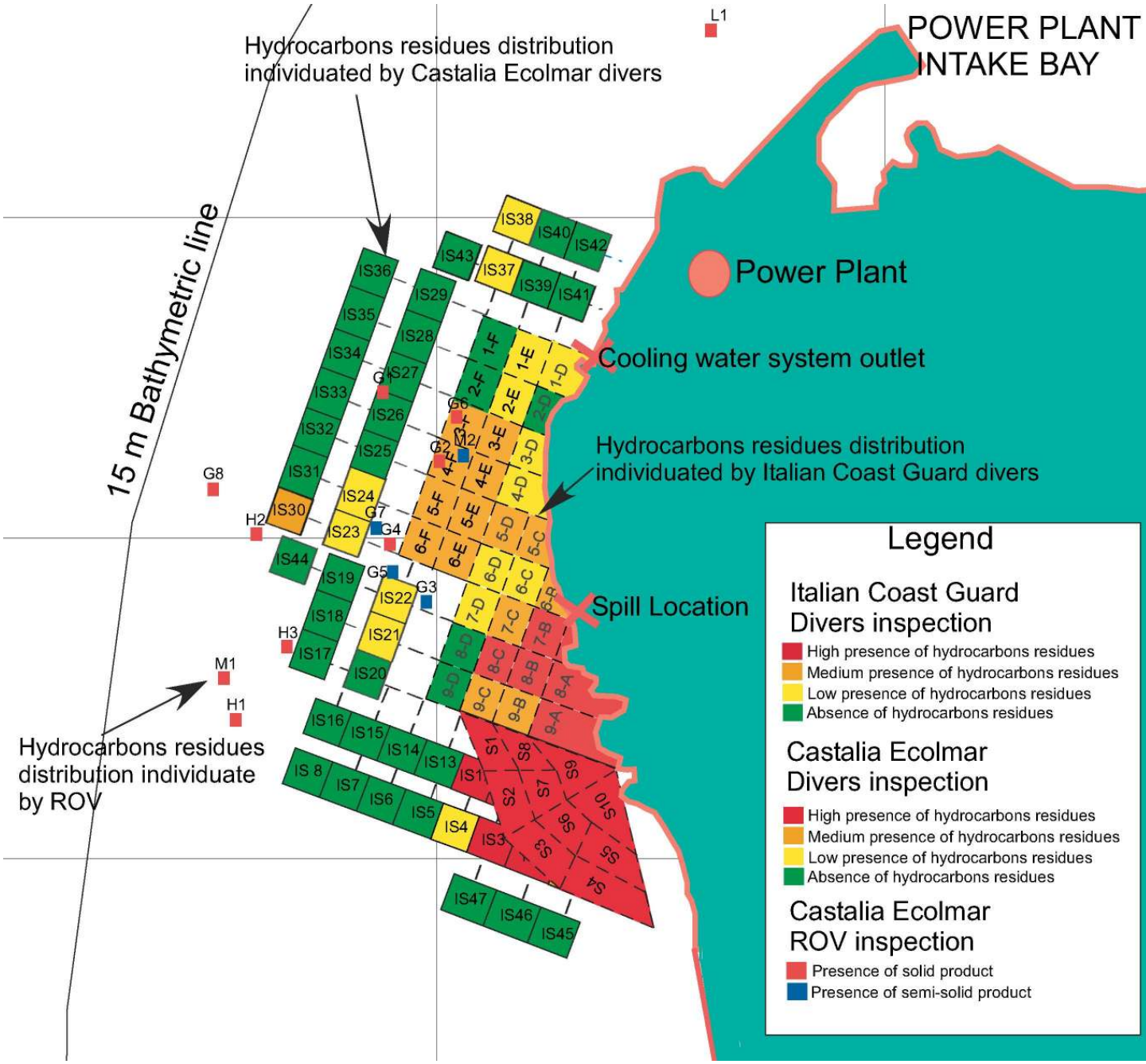
Average depth:	5 meters
Sea bottom geomorphology:	mainly rocky
Pollutant consistence:	mainly solid
Pollutant concentration:	high

S-9

Average depth:	3 meters
Sea bottom geomorphology:	mainly rocky
Pollutant consistence:	mainly solid
Pollutant concentration:	high

S-10

Average depth:	3 meters
Sea bottom geomorphology:	mainly rocky
Pollutant consistence:	mainly solid
Pollutant concentration:	high


L1
POWER PLANT
INTAKE BAY
Hydrocarbons residues distribution
individuated by Castalia Ecolmar divers
15 m Bathymetric line
Power Plant
Cooling water system outlet
Hydrocarbons residues distribution
individuated by Italian Coast Guard divers
Spill Location
G8
H2
H3
M1
H1
G1
G2
G3
G4
G5
G6
G7
M2
Hydrocarbons residues
distribution individuate
by ROV
Legend
Italian Coast Guard
Divers inspection
High presence of hydrocarbons residues
Medium presence of hydrocarbons residues
Low presence of hydrocarbons residues
Absence of hydrocarbons residues
Castalia Ecolmar
Divers inspection
High presence of hydrocarbons residues
Medium presence of hydrocarbons residues
Low presence of hydrocarbons residues
Absence of hydrocarbons residues
Castalia Ecolmar
ROV inspection
Presence of solid product
Presence of semi-solid product

Grid concentration chart

The total navigation hours in operation area for the “Peluso” ship have been 263 corresponding to 1738 nautical miles

A total of 30 meters of absorbent booms have been employed in antipollution operations.

The total dive hours for the entire operation amount to 197.

The amount of data collected allows to make the following considerations:

- Immediately after the accident the heavy portion of the product appears to have sunken to the sea bottom following the geomorphology of the rocks in accordance with the physical characteristics of the pollutants;
- The pollutant is trapped almost only in the underwater pools in the close nearby of the spillage point. On the sandy floor the pollutant seems not to have stopped (apparently due to the currents and surf);
- The essays on the pollutant consistence tend to confirm the hypothesis that the more solid part of the pollutant is concentrated in the northern peripheral part of the polluted area;
- Despite the attempts it has been impossible to evaluate the amount of pollutant present on the sea bottom due to the irregular shape of the patches contour and their non homogenous thickness.

ITALIAN COAST GUARD FLIGHT SERVICE

REPORT ON THE ACTIVITIES
LEBANON COAST SEPTEMBER 27 – OCTOBER 06

INTRODUCTION

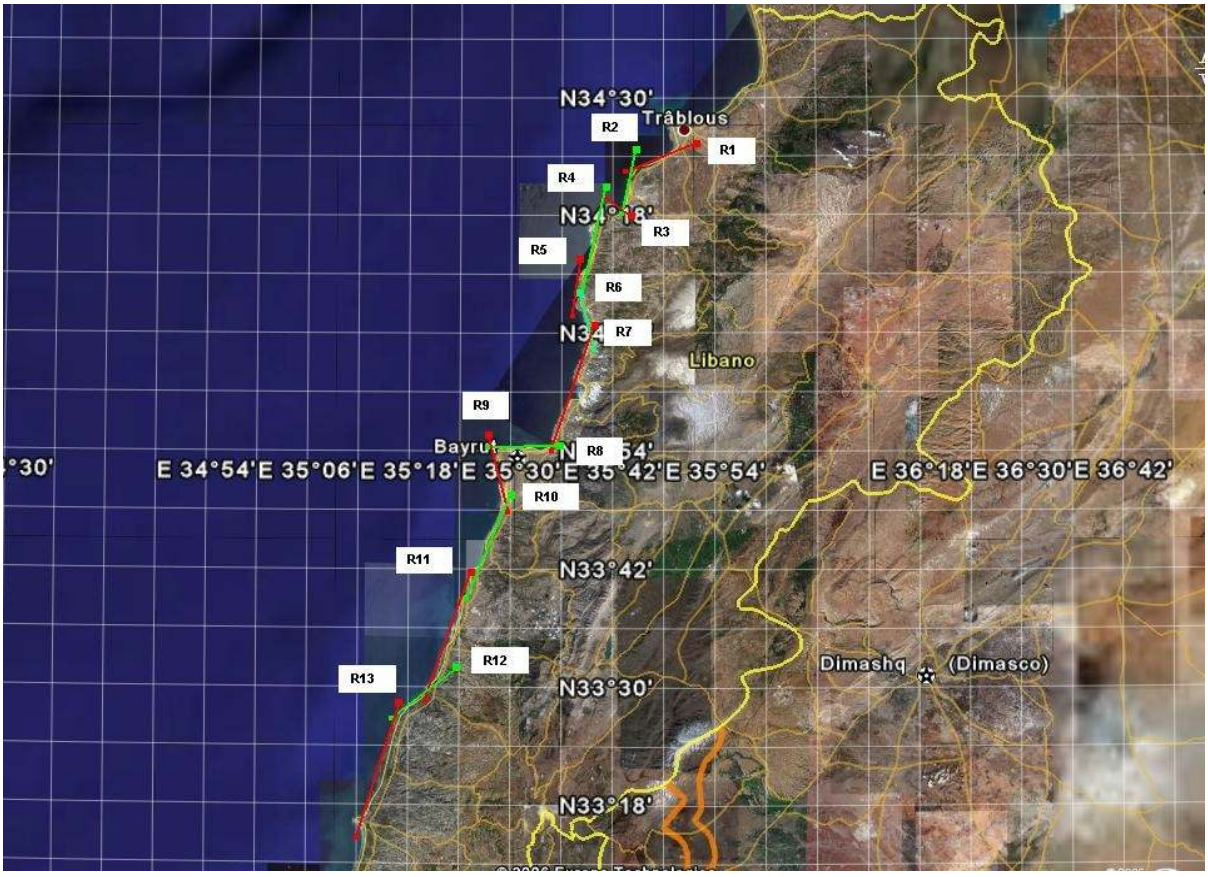
The main task of the Italian ATR 42 MP has been to carry out remote sensing operations over the Lebanese coast and off shore waters facing the coastline between Trablous and Saida.

The technical equipment of the aircraft consists of:

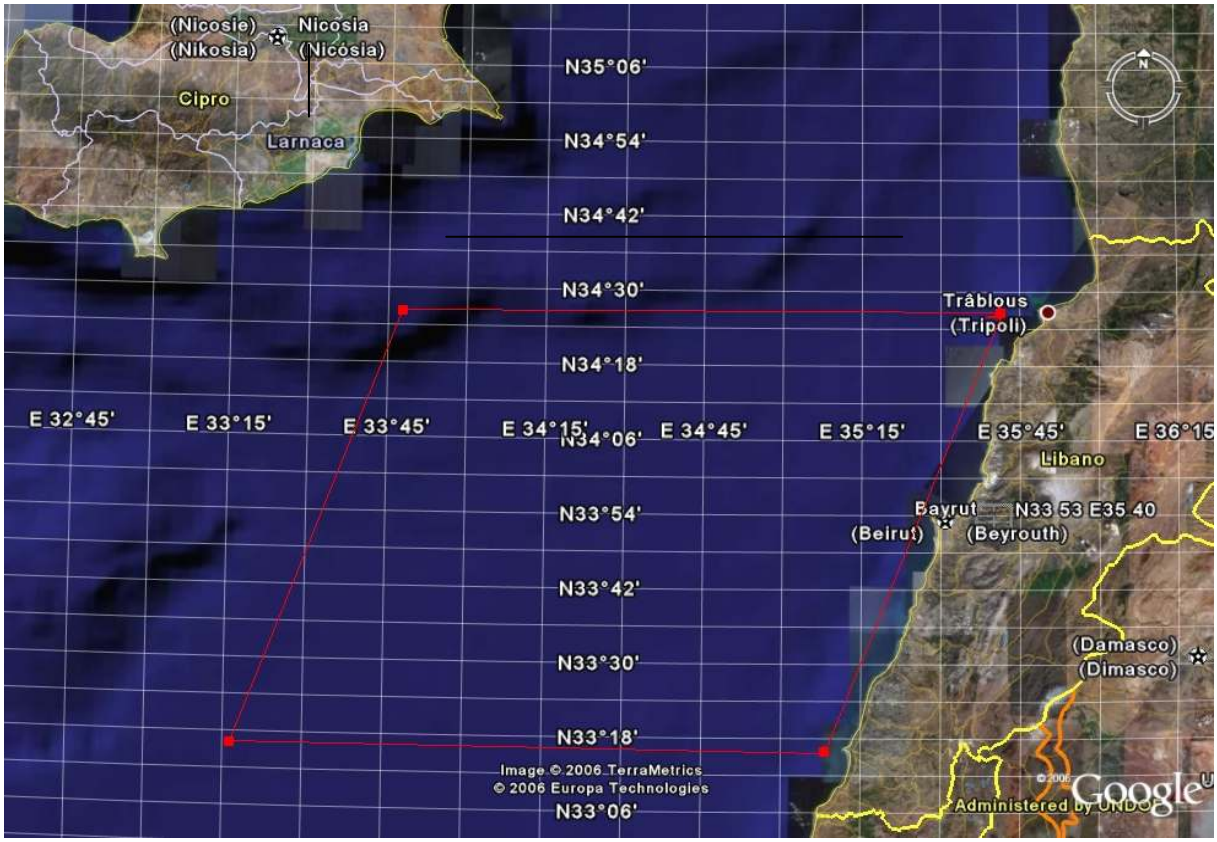
- SLAR (Side Looking Airborne Radar) for high sea wide range pollution detection;
- EOST (Electro Optical Surveillance Turret) for video recording both in visual and infrared;
- ATM (Airborne Thematic Mapping) for water quality monitoring.

The operational orders have been tailored to comply to the assigned task.

OPERATIONAL ORDER ONE



OPERATIONAL ORDER TWO



OPERATION'S CHRONOLOGY

27.09.2006

FLIGHT SCHEDULE

LARNAKA (LCLK) 27 04.20Z	**BEIRUT (OLBA) 27 05.05Z**	**FERRY ANTIPOLLUTION**	**45 '**
BEIRUT (OLBA) 27 06.00Z	**BEIRUT (OLBA) 27 09.10Z**	**ANTIPOLLUTION**	**3 h 10'**
BEIRUT (OLBA) 27 11.35 Z	**LARNAKA (LCLK) 27 1240 Z**	**FERRY ANTIPOLLUTION**	**1 h 05'**

The flight has been conducted at 3000 ft flying over the entire Lebanese coastline from Trablous to Saida to have an overall look on the emergency and searching for polluted areas using on board sensors (ATM, SLAR, EOST, Digital Camera).

The sites that appear to be the more polluted are the areas north of Beirut and in particular the coast along the city and the harbour of Trablous and all the shoreline between Jieh and the north of Beirut.

Those zones are interested by an homogeneous iridescent slick that can be observed with no discontinuity.

In the south of Beirut the more polluted area is around the power station of Jieh extending from the coast toward the open sea for about 5 miles.

Particularly the area around the power station is interested by a continuous iridescence.

The coastline has been monitored with the ATM sensor performing 14 legs for a total length of 132 miles, every leg has a width of 1700 meters with a ground resolution of 2,3 meters.

The pollution can be described as scattered.

28.10.2006

FLIGHT SCHEDULE

LARNAKA (LCLK) 28 0510Z	**BEIRUT (OLBA) 28 0605Z**	**FERRY/ANTIPOLLUTION**	**55 ’**
BEIRUT (OLBA) 28 0640Z	**LARNAKA (LCLK) 28 1025Z**	**FERRY/ANTIPOLLUTION**	**3 h 45’**

The flight has been carried out within the area depicted as “operational order two” in compliance with the operational order.

The flight has been conducted at 4000 ft executing a creeping line with four legs of approximately 70 miles with a spacing of 24 miles using the SLAR system as primary sensor.

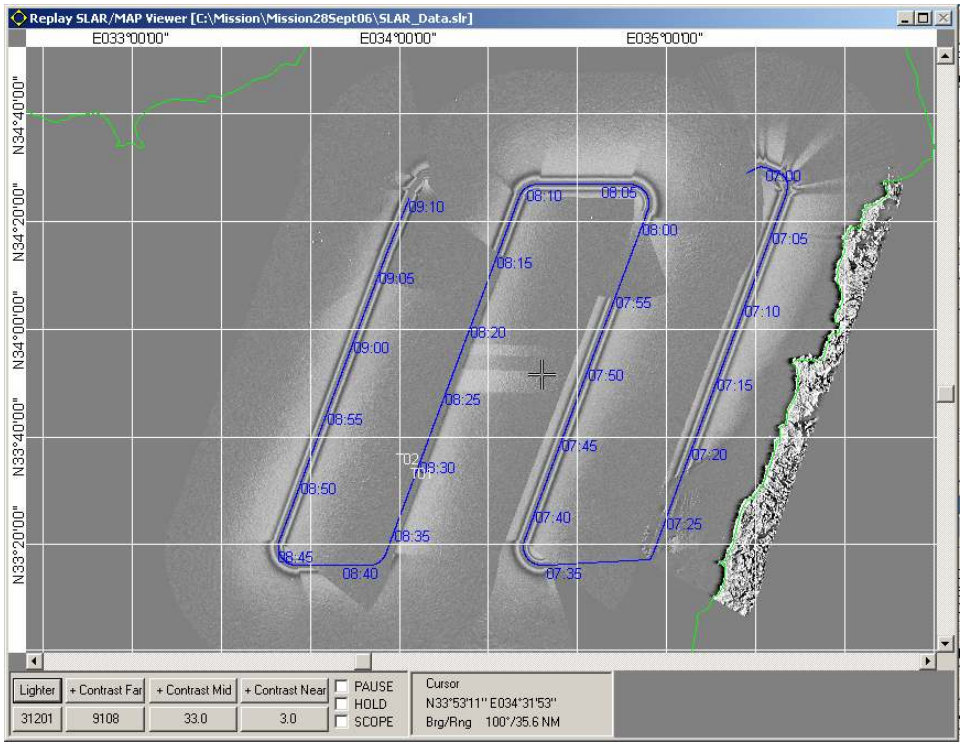
The total area covered has an extension of approximately 5800 square miles and no evidence of pollution along the coastline has been detected.

In the central part of the assigned zone, the meteorological conditions permitted to the system to discover some light slicks with an extension of 0.2 to 0.5 square kilometres in the positions listed below:

a) 33° 37’ 30’’ N – 033° 59’ 15’’ E ;

b) 33° 34’ 38’’ N – 034° 02’ 12’’ E ;

Digital pictures and video recording in the visible and infrared fields have been taken.



SLAR image of the area taken at 4000 Ft.

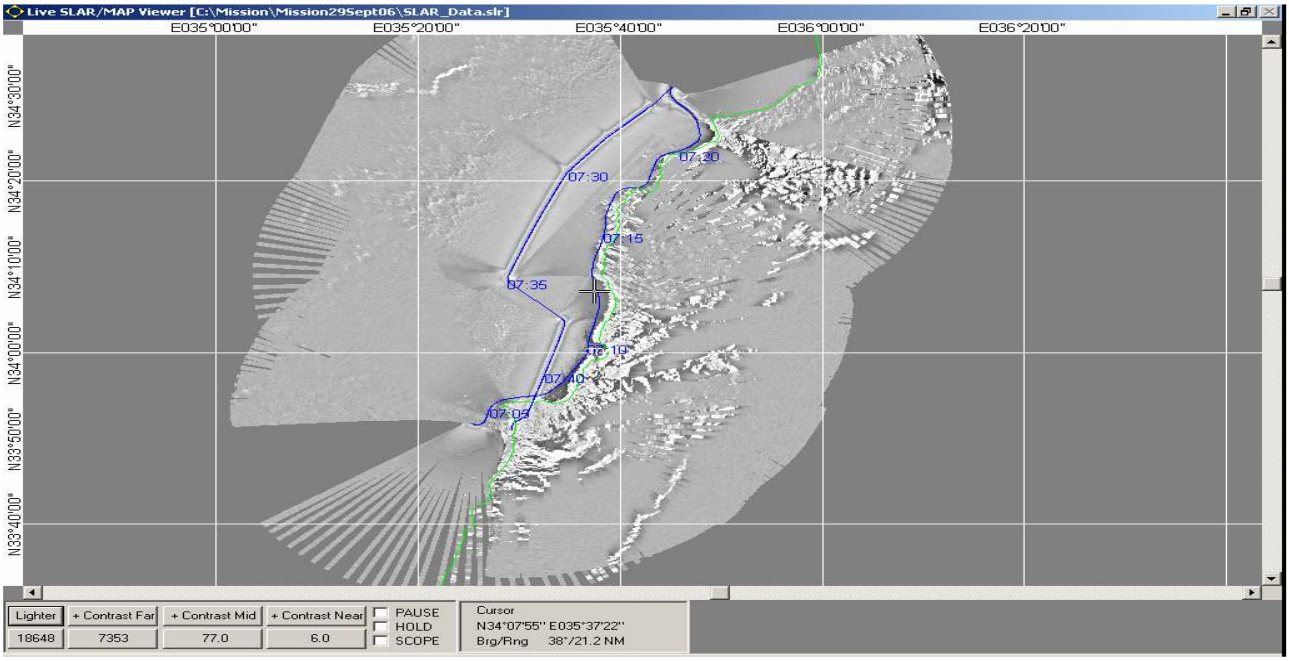
29.09.2006

LARNAKA (LCLK) 29 05.15Z	**BEIRUT (OLBA) 29 06.10Z**	**FERRY ANTIPOLLUTION**	**55 ’**
BEIRUT (OLBA) 29 06.45Z	**BEIRUT (OLBA) 29 09.40Z**	**ANTIPOLLUTION**	**2 h 55’**
BEIRUT (OLBA) 29 10.05Z	**LARNAKA (LCLK) 29 11.05Z**	**FERRY ANTIPOLLUTION**	**1 h 00’**

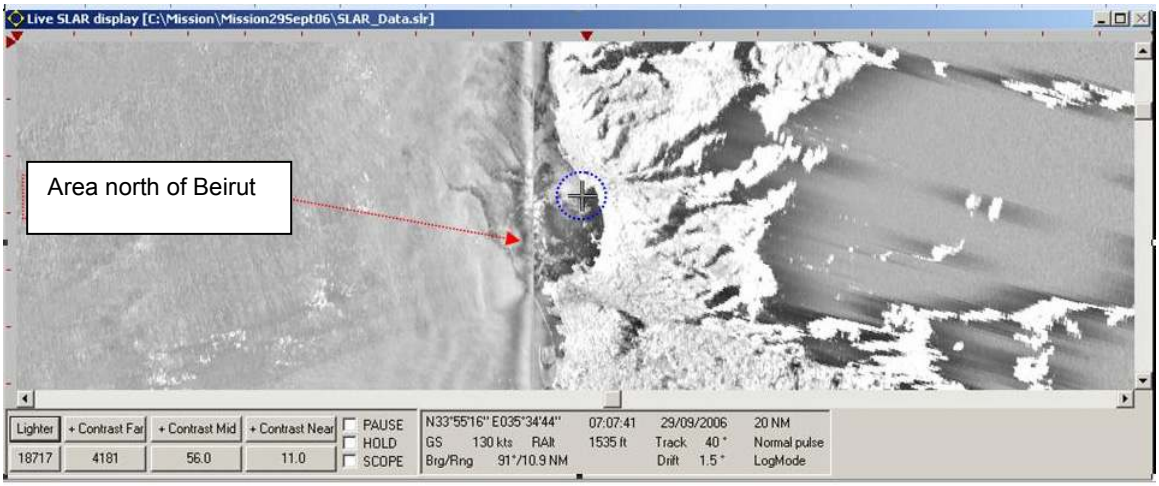
The flight has been carried out within the area depicted as “operational order one” in compliance with the operational order.

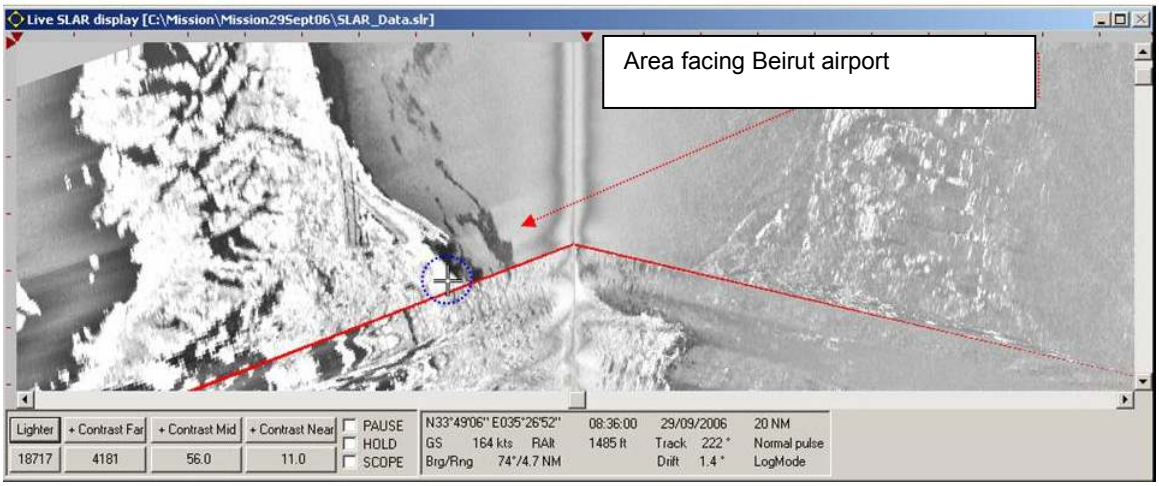
The flight has been conducted at 1500 ft flying over the coastline from Trablous to Sour, SLAR has been used as primary sensor for off-shore monitoring and EOST has been used as primary sensor for coastline monitoring visible and infrared images have been taken.

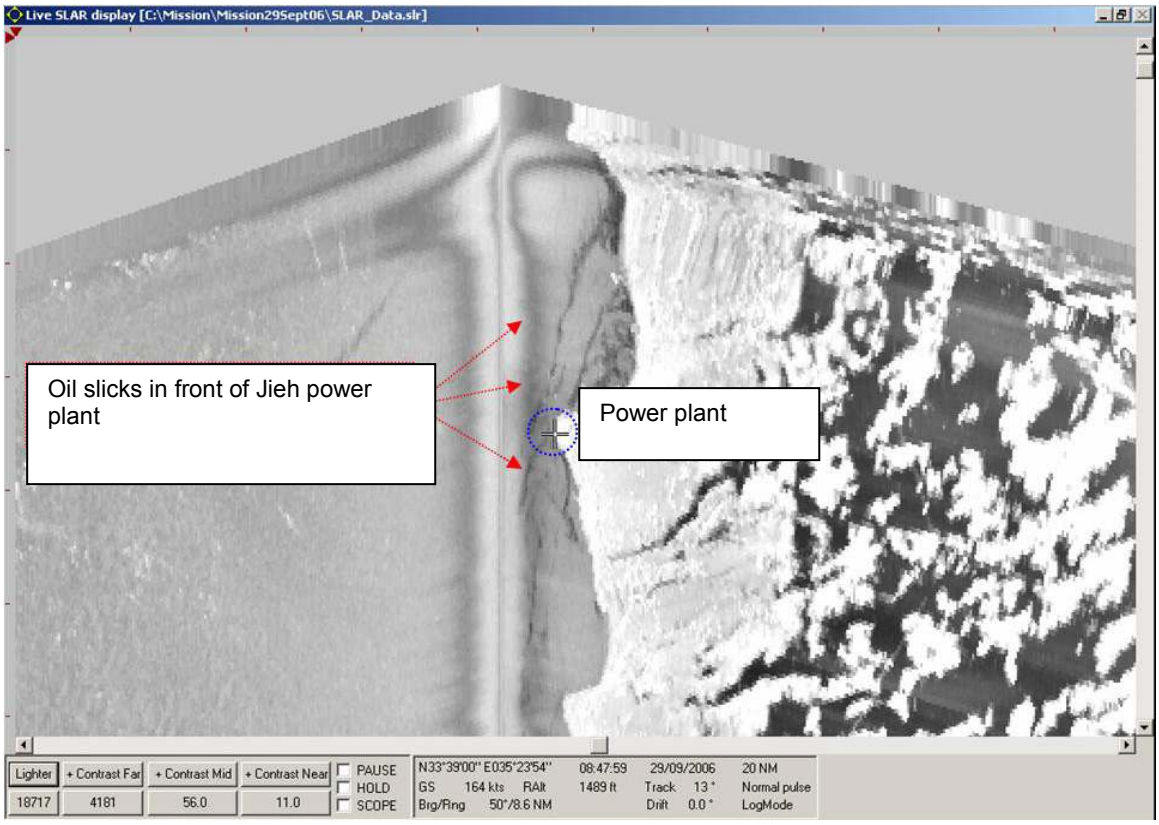
The SLAR survey confirmed the presence of oil slicks along the coastline



Total flight path depiction







SLAR images at 1500 Ft.

02.10.2006

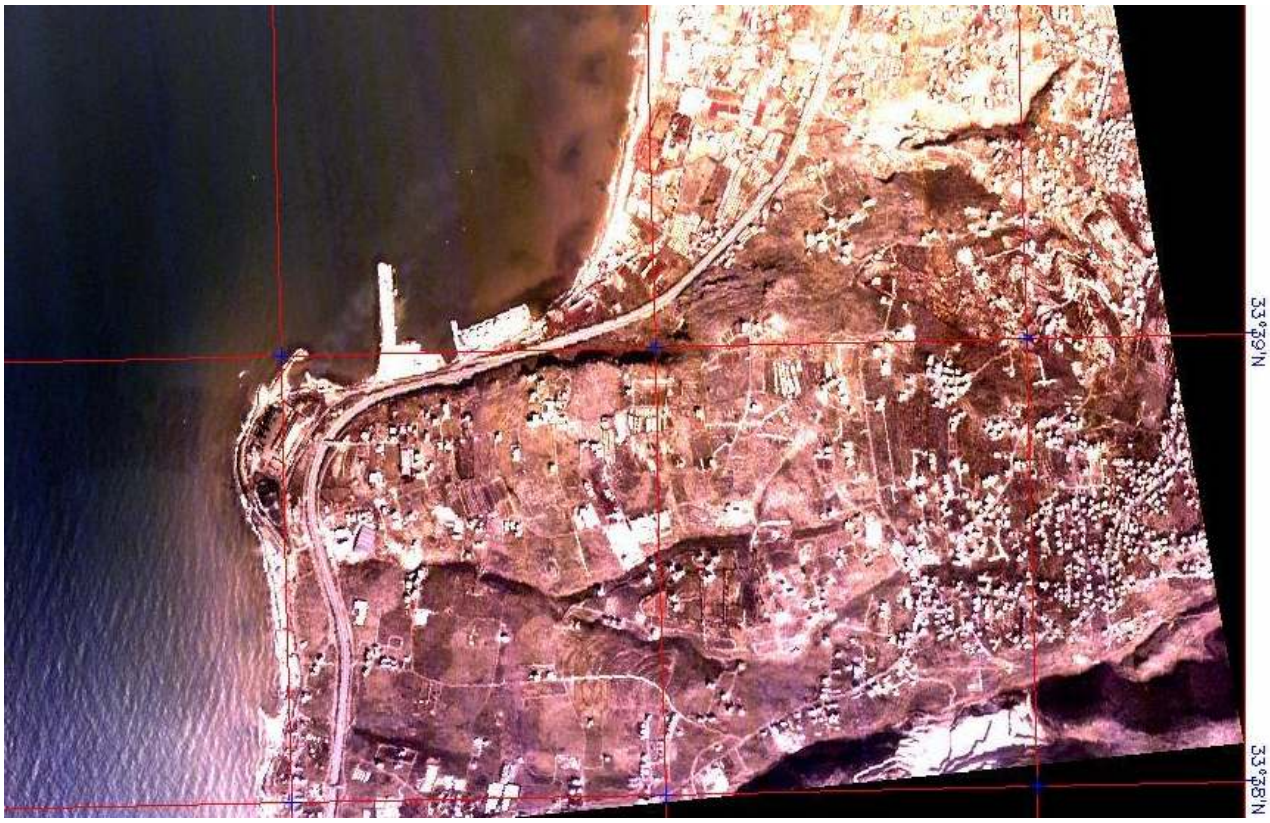
FLIGHT SCHEDULE

LARNAKA (LCLK) 02 05.30Z	**BEIRUT (OLBA) 02 06.30Z**	**FERRY ANTIPOLLUTION**	**1 h**
BEIRUT (OLBA) 02 07.00Z	**LARNAKA (LCLK) 02 11.00Z**	**FERRY ANTIPOLLUTION**	**4 h**

The flight has been carried out between Saida and Jabail in compliance with the operational order.

The patrolling altitude has been of 8000 Ft. which lead up with a width of 10 miles and ATM the main sensor employed.

Due to clouds coverage the flight portion between Jabail to Trablous has not been monitored.



ATM Image of Jieh Power Plant area

04.10.2006

FLIGHT SCHEDULE

LARNAKA (LCLK) 04 05.45Z	**LARNAKA (LCLK) 04 08.55Z**	**ANTIPOLLUTION**	**3 h 10'**

The flight has been carried out between Beirut and Trablous in compliance with the operational order.

The flight has been conducted at 8000 ft using ATM as mains sensor, flying over the coast to a distance of 10 miles effectuating 30 legs east/west oriented with a width of 2 miles each and a grund resolution of 6 meters.

CONCLUSIONS

The flight activity has concurred to make a complete surface picture and supply adequate information concerning the pollution.

Numerous slicks have been located in the area between Jieh and the north of Trablous.

The slicks where mainly iridescent and of small dimensions.

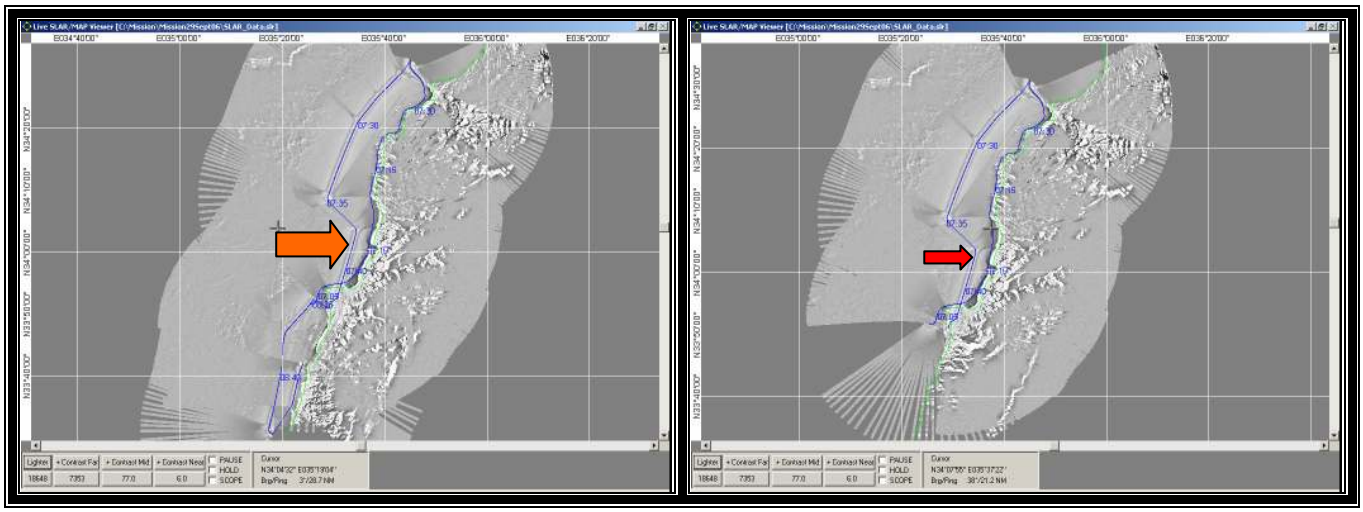
The Palms Islands area is not, at present, interested by the pollution, while on some points of the beaches and reefs there are obvious fuel oil traces.

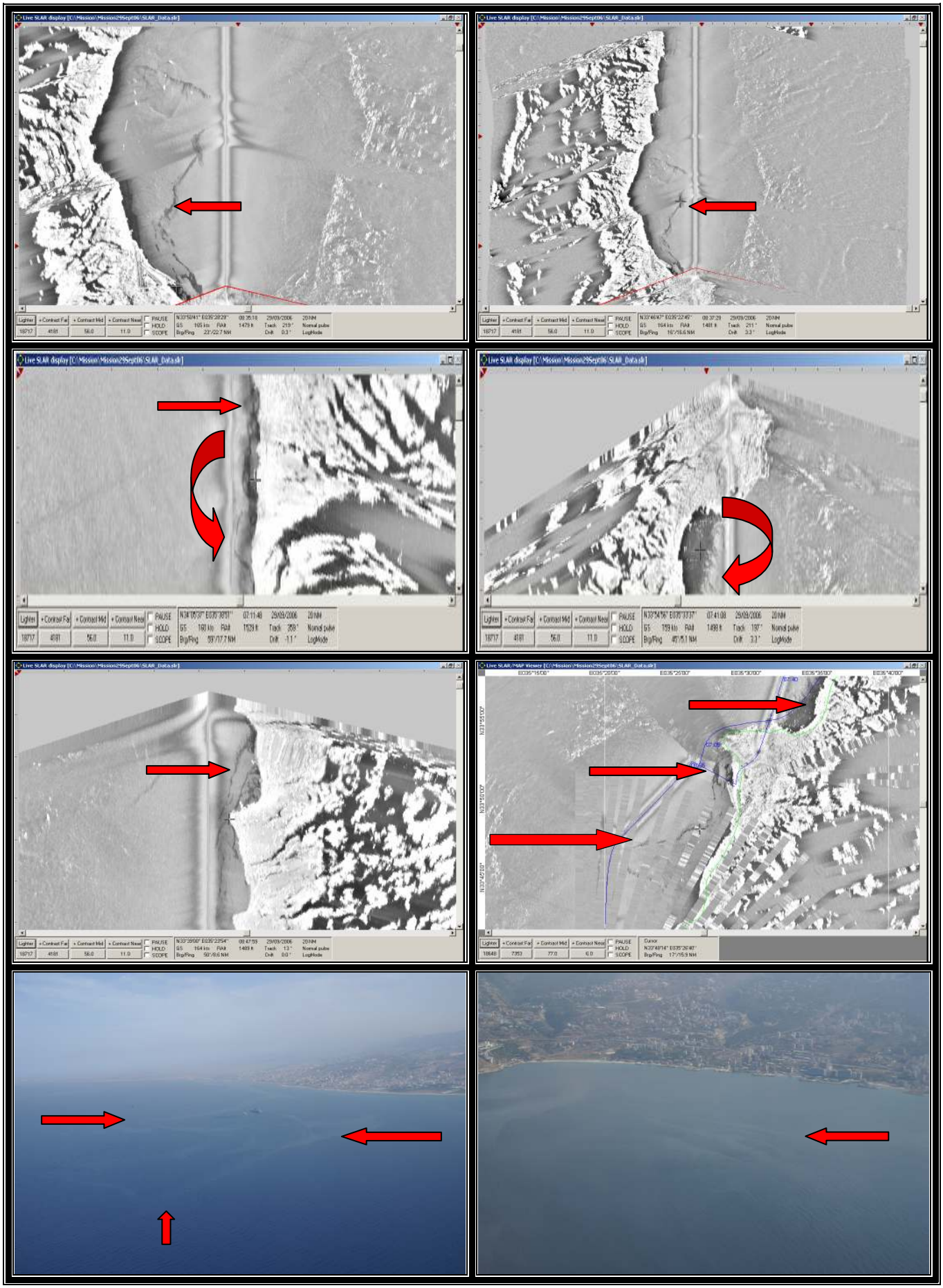
The beaches located in the north area zone close the Beirut port are rather affected by the oil.

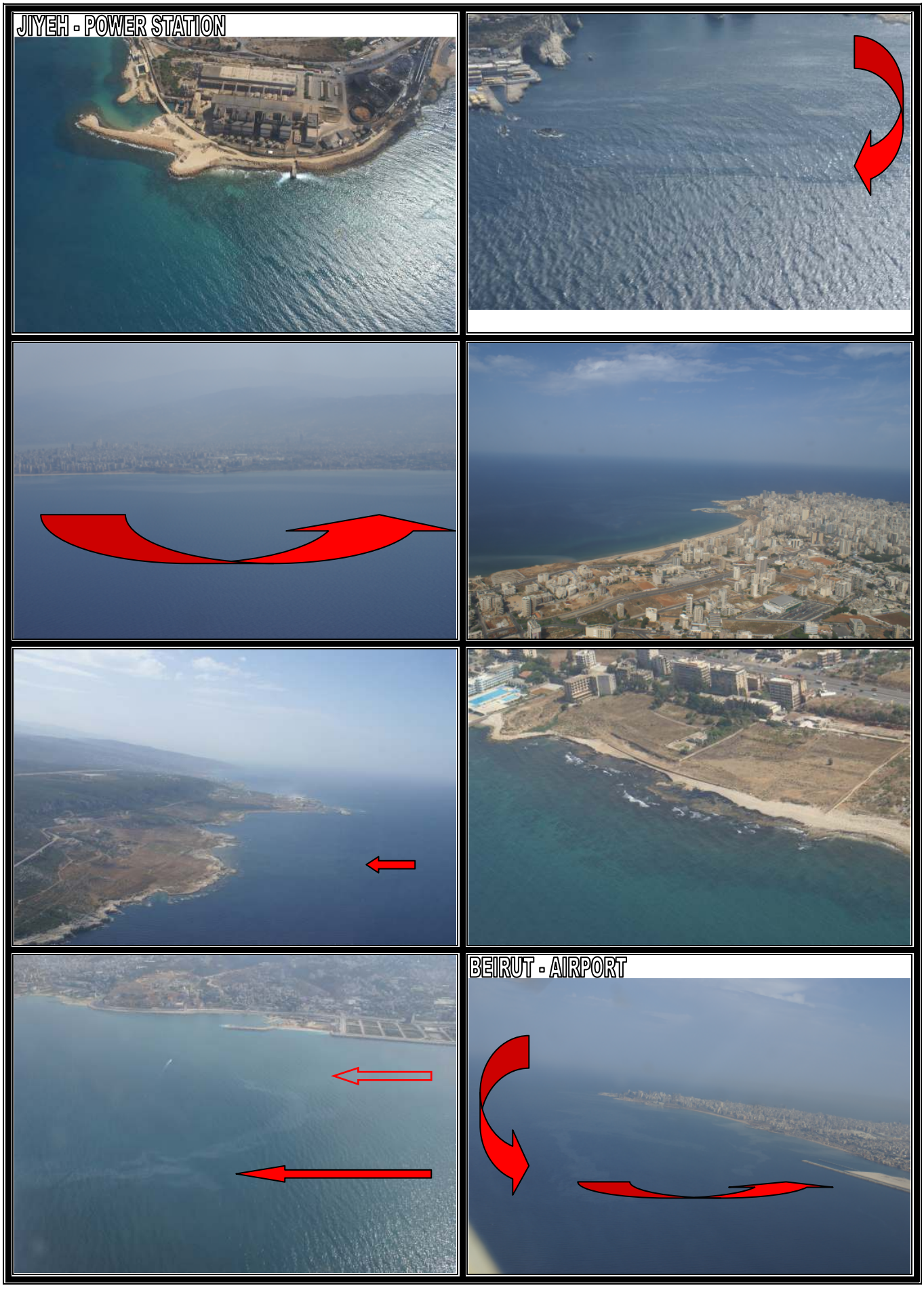
Extended slicks of product with low consistency are detectable from south of Jieh power plant (1/2 miles).

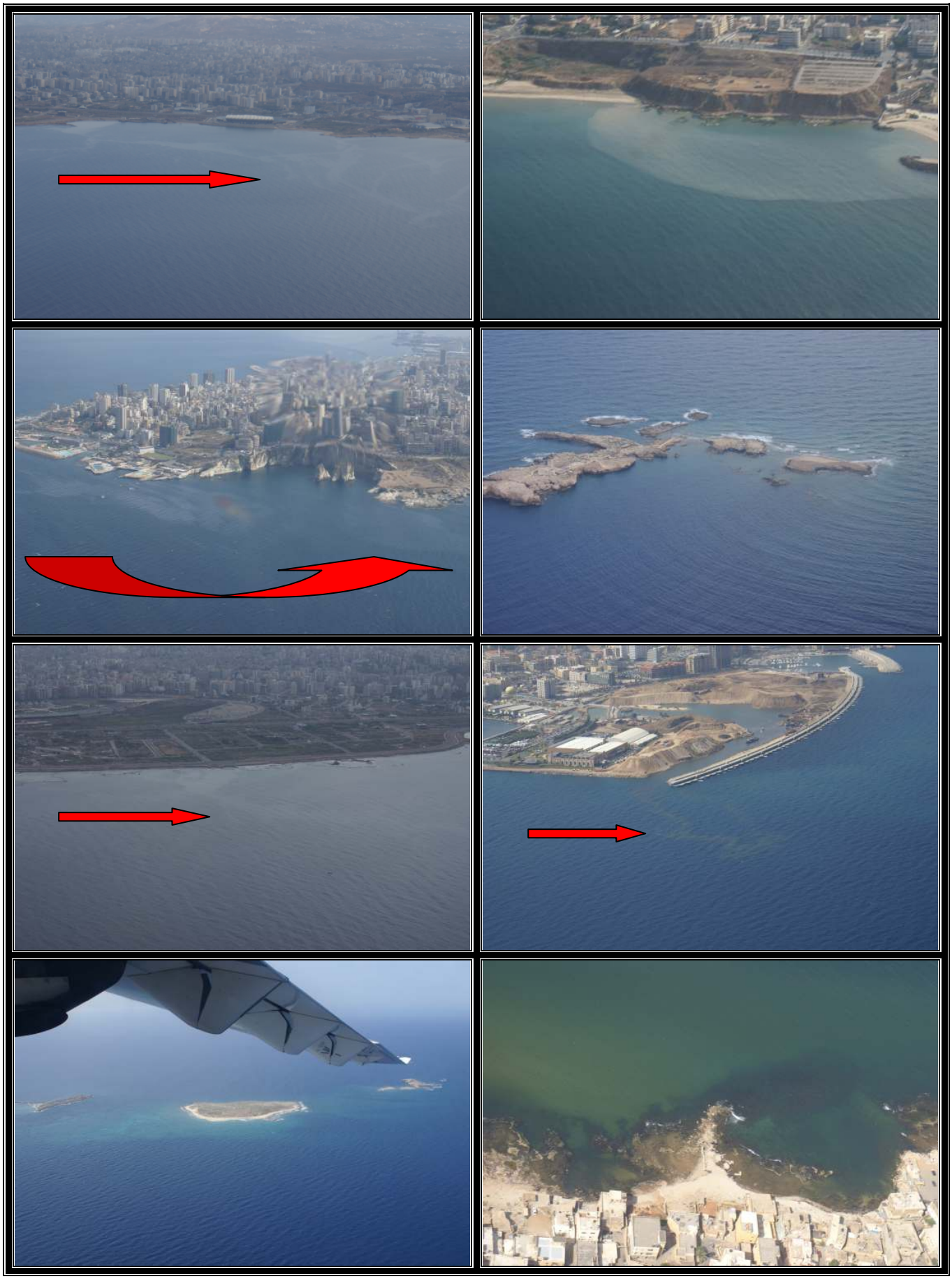
Apart from slicks detected during the second flight day no more slicks were detected during the off shore patrol.

Data collected with ATM sensor is collected in the attached report.






JIYEH - POWER STATION
BEIRUT - AIRPORT



AIRBORNE THEMATIC MAPPER

Sensyetch AA1268 ATM

FINAL REPORT

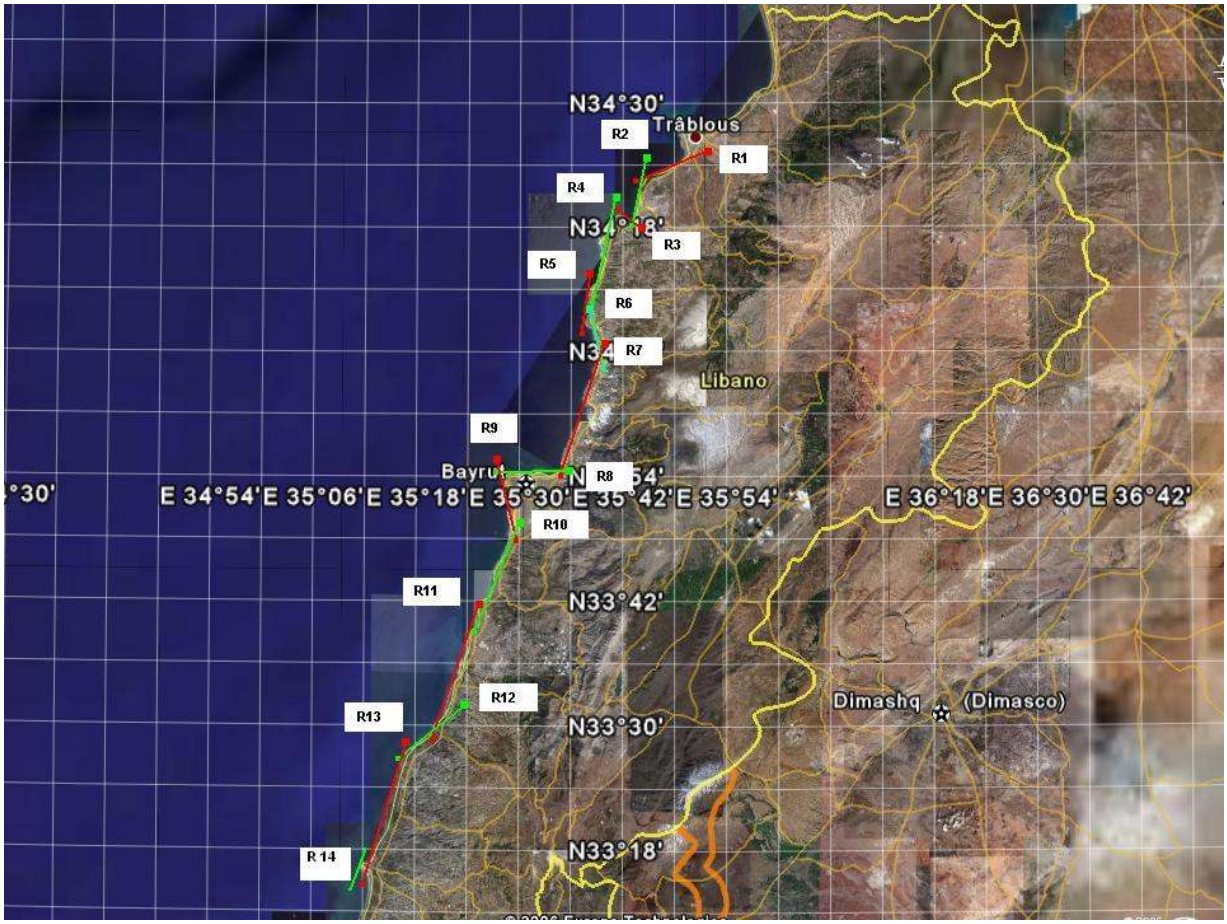
GENERAL PLANNING

The Lebanese coastline remote sensing has been performed from an altitude of 3000 Ft. using the Sensytech AA1268 ATM sensor.

14 legs have been flown for a total of 132 nautical miles, each leg covers a width of 1700 meters with a ground resolution of 2.3 meters.

The analysis of the processed images has evidenced the sites where the pollutant has grounded.

It has not been possible to evidence the sunken pollutant due to the particular conditions of the sea bottom (pollutant covered by sand or hidden between rocks).



General leg planning

DATA PROCESSING INFORMATION

The characterization of the images has used, as a reference, bituminous material in order to have the same response of grounded pollutant.

The pollutant is evidenced in red colour on the images, and, due to the reference material choice, also on ground sites, where bitumen is present on streets and other sites, are evidenced in red and thus are not to be taken in account.

For each leg two images are provided, the first one is the raw scanning image, the second one is the processed one; the topographical references, geographical coordinates, covered area, length and orientation are also given.

A CD with all the images, both raw and processed is attached to this report in order to use the images for environmental purposes.

LEG ONE

Trablous – Ras en Natour

Start point: 34°25’43”N 035°51’54”E

End point: 34°21’15”N 035°43’12”E

Leg length: 8.5 NM

Leg orientation: 239°

Covered area: 26.8 Square Kilometres

Raw data image

Processed image

LEG TWO

Ras en Natour – El heri

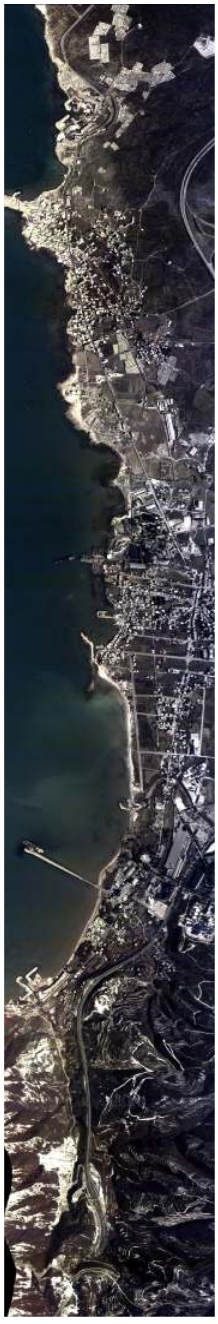
Start point: 34°24’54”N 035°45’34”E

End point: 34°17’42”N 035°42’36”E

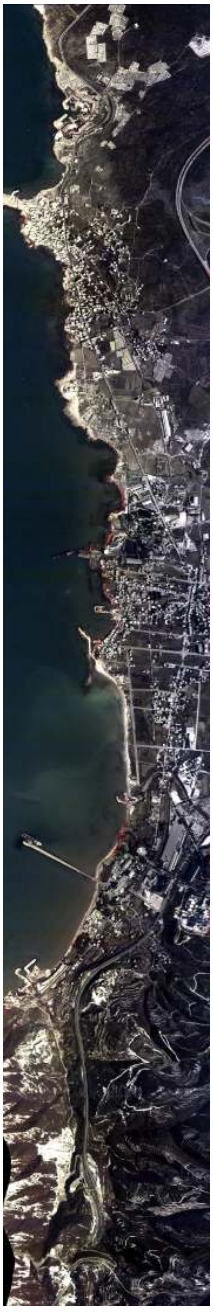
Leg length: 7.6NM

Leg orientation:199°

Covered area: 24 Square Kilometres



Raw data Image



Processed Image

LEG THREE

El Heri – Ras ech Chaquaa

Start point: 34°16’51”N 035°45’27”E

End point: 34°19’262N 035°40’30”E

Leg length: 4.9 NM

Leg orientation:302

Covered area: 15.5 Square Kilometres

Raw data Image

Pprocessed Image

LEG FOUR

Ras ech Chaquaa – Ras Amchit

Start point: 34°21’18”N 035°41’15”E

End point:34°11’42”N 035°38’53”E

Leg length: 9.9 NM

Leg orientation: 191°

Covered area:31.2 Square Kilometres

Row data Image

Processed Image

LEG FIVE

Ras el Berbara – Ras Amchit

Start point: 34°15’00”N 035°38’27”E

End point: 34°07’30”N 035°37’39”E

Leg length: 7.7 NM

Leg orientation: 186°

Covered area: 24.3 Square Kilometres

Row data Image

Processed Image

LEG SIX

Ras Amchit – Nahr Ibrahim

Start point: 34°11’33”N 035°38’09”E

End point: 34°03’36”N 035°39’08”E

Leg length: 8.1NM

Leg orientation: 174°

Covered area: 25.5 Square kilometres

Row data Image

Processed Image

LEG SEVEN

Nahr Ibrahim - Antelias

Start point: 34°07’07”N 035°39’54”E

End point: 33°53’52”N 035°33’11”E

Leg length: 14.2 NM

Leg orientation:203°

Covered area: 44.8 Square Kilometres

Raw data Image

Processed Image

LEG EIGHT

Antelias – Ras beirut

Start point: 33°54’27”N 035°37’48”E

End point: 33°54’03”N 035°27’36”E

Leg length: 8.6 NM

Leg orientation: 267°

Covered area: 27 Square Kilometres

Raw data Image

Processed Image

LEG NINE

Ras Beirut – Beirut Airport

Start point: 33°57’00”N 035°27’51”E

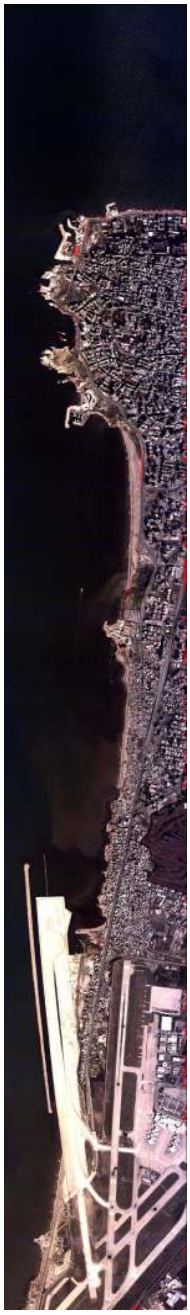
End point: 33°47’24”N 035°29’13”E

Leg length: 9.6 NM

Leg orientation:173°

Covered area: 30.2 Square Kilometres

Raw data Image



Processed Image

LEG TEN

Beirut Airport – Ras es Saardivat

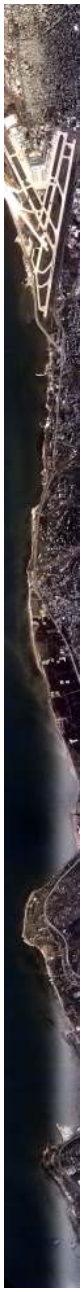
Start point: 33°52’12”N 35°30’12”E

End point: 33°38’24”N 035°24’13”E

Leg length: 14.8 NM

Leg orientation: 200°

Covered area:46.6 Square Kilometres



Raw data Image

Processed Image

LEG ELEVEN

Ras es Saardivat – El Aadoussiè

Start point: 33°41’42”N 035°25’32”E

End point: 33°30’03”N 035°20’42”E

Leg length: 12.7 NM

Leg orientation: 199°

Covered area: 40 Square Kilometres

Raw data Image

Processed Image

LEG TWELVE

Saida Petrol Terminal – Ras Sarafand

Start point: 33°32’58”N 035°24’00”E

End point: 33°25’48”N 035°15’34”E

Leg length:10.1 NM

Leg orientation:225°

Covered area: 31.8 Square Kilometres

Raw data Image

Processed Image

LEG THIRTEEN

Ras en Sarafand - Tyre

Start point: 33°28’48”N 035°17’33”E

End point: 33°14’24”N 035°12’15”E

Leg length: 15.2 NM

Leg orientation: 197°

Covered area: 47.9 Square Kilometres

Raw data Image

Processed Image

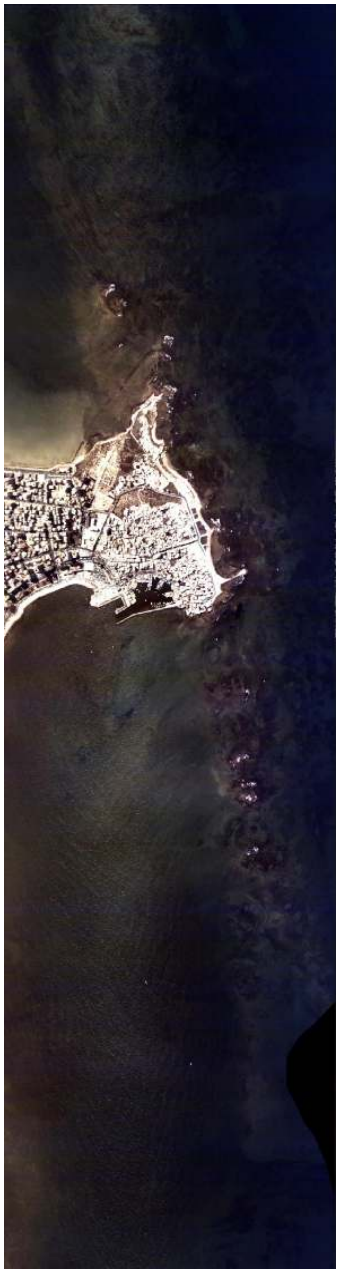
LEG FOURTEEN

Tyre Area

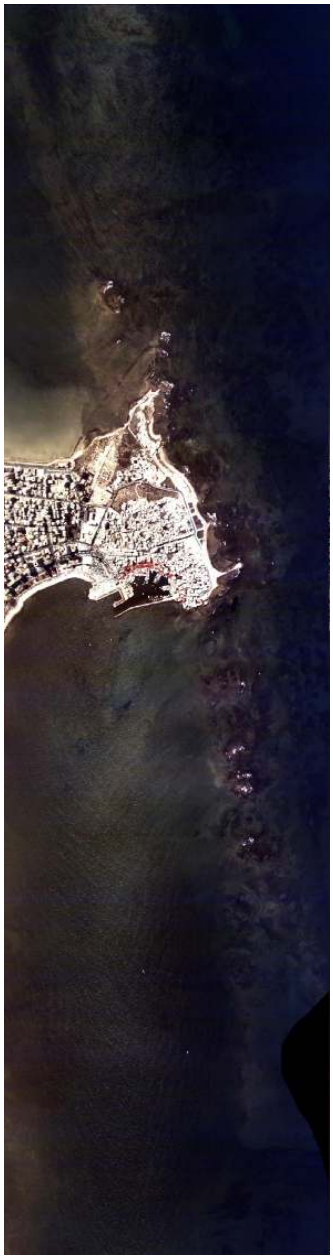
Leg length: 4.2 NM

Leg orientation: 007°

Covered area:13.2 Square Kilometers



Raw data Image



Processed Image

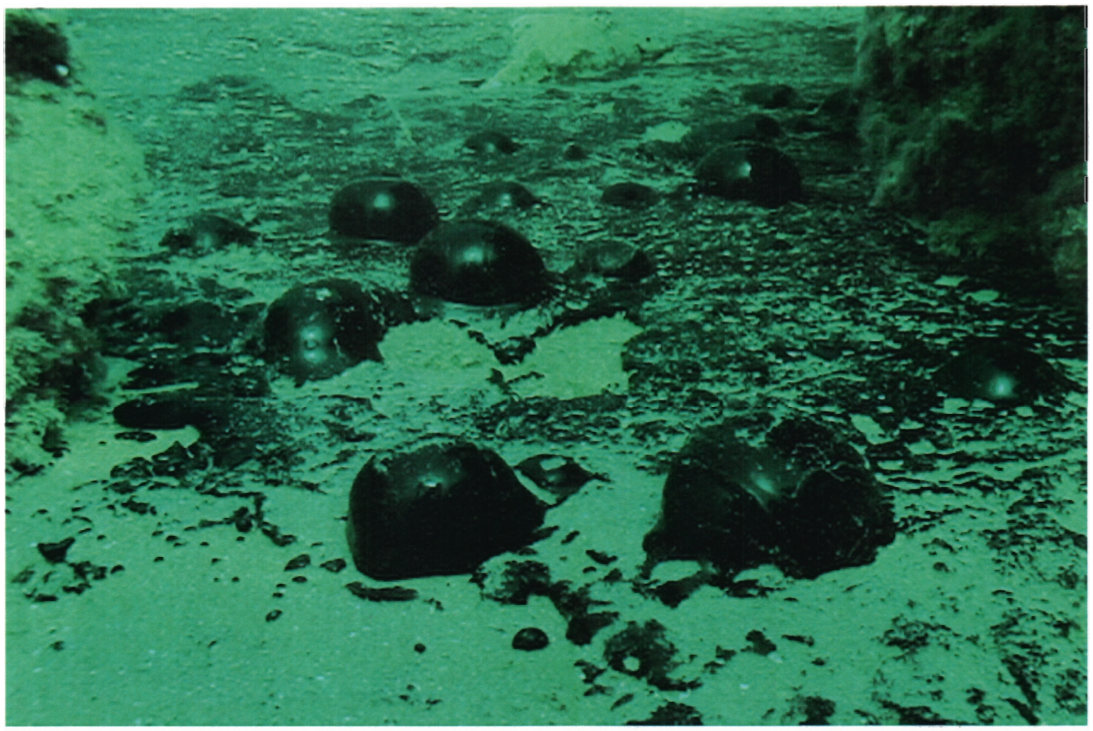
REPORT ON THE ACTIVITIES

JIEH SEPTEMBER 24 -NOVEMBER 02

Ministero dell'Ambiente
e della Tutela del Territorio

CASTALIA ecolmar

UNDER WATER SURVEY OF THE JIEH COAST (POWER PLANT) BY ROV (REMOTE OPERATED VEHICLE) & DIVERS



24 september - 13 october 2006

DOCUMENT CODE: RTE 10					
PROJECT: PRO 021					
DOCUMENT TITLE - Under water survey of the Jieh coast (power plant) by rov (remote operated vehicle) & divers					
0	29/10/2006		Mirto Supino	Morucci	Arazzini
REV.	DATA	NOTE	WRITEN	VERIFIED	APPROVED

INDEX

1. INTRODUCTION

Following the explosion of some of the fuel tanks of the Jiyeh power plant and the consequent spill, in the frame of the Italian Ministry of Environment Mission, an underwater survey of the coastal area in front of the power plant has been performed with a Remote Operated Vehicle (ROV) and divers.

The purpose of the survey was to identify the areas of accumulation of hydrocarbons residues for the remediation of the area.

Figure 1

JIYEH Power plant–LIBANON

2. AREA INTERESTED BY THE SURVEY

The zone interested by the survey has been divided in two specific areas.

The first area (Map 1) is limited to in the small bay of the cooling system intake.

The second controlled area (Map 2) interested by the underwater survey is delimited:

- North by the Sibline dock
- South until 200 m south of the power plant area
- Offshore by the 15 m bathymetric line.

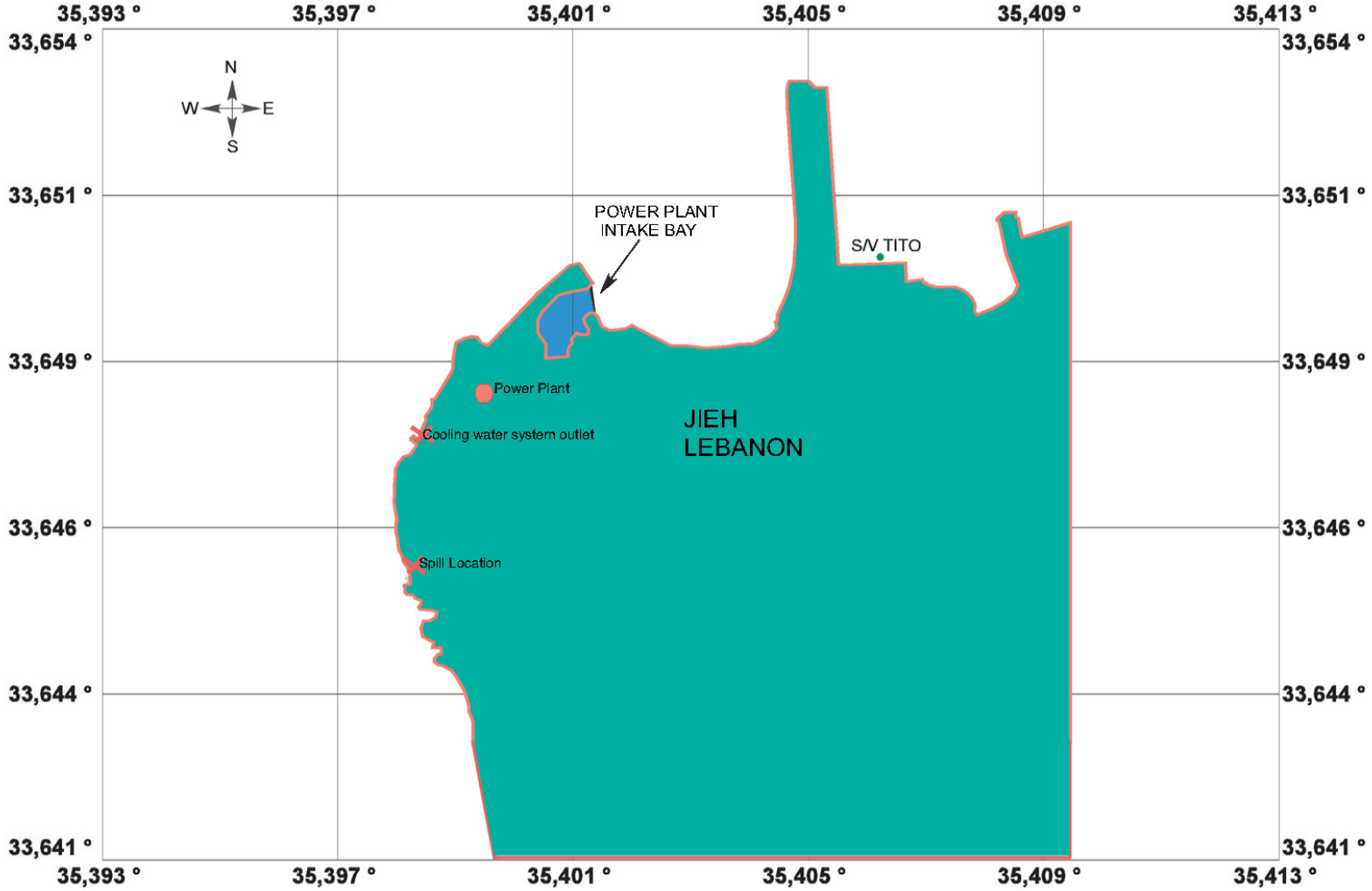
The total surface of the surveyed area is about 700.000 m2.

The control of the second area has been subdivided in a “coastal survey” and in an “offshore survey”.

The survey of the coastal area (represented in red in map 2) has been performed by the Italian coast guard divers.

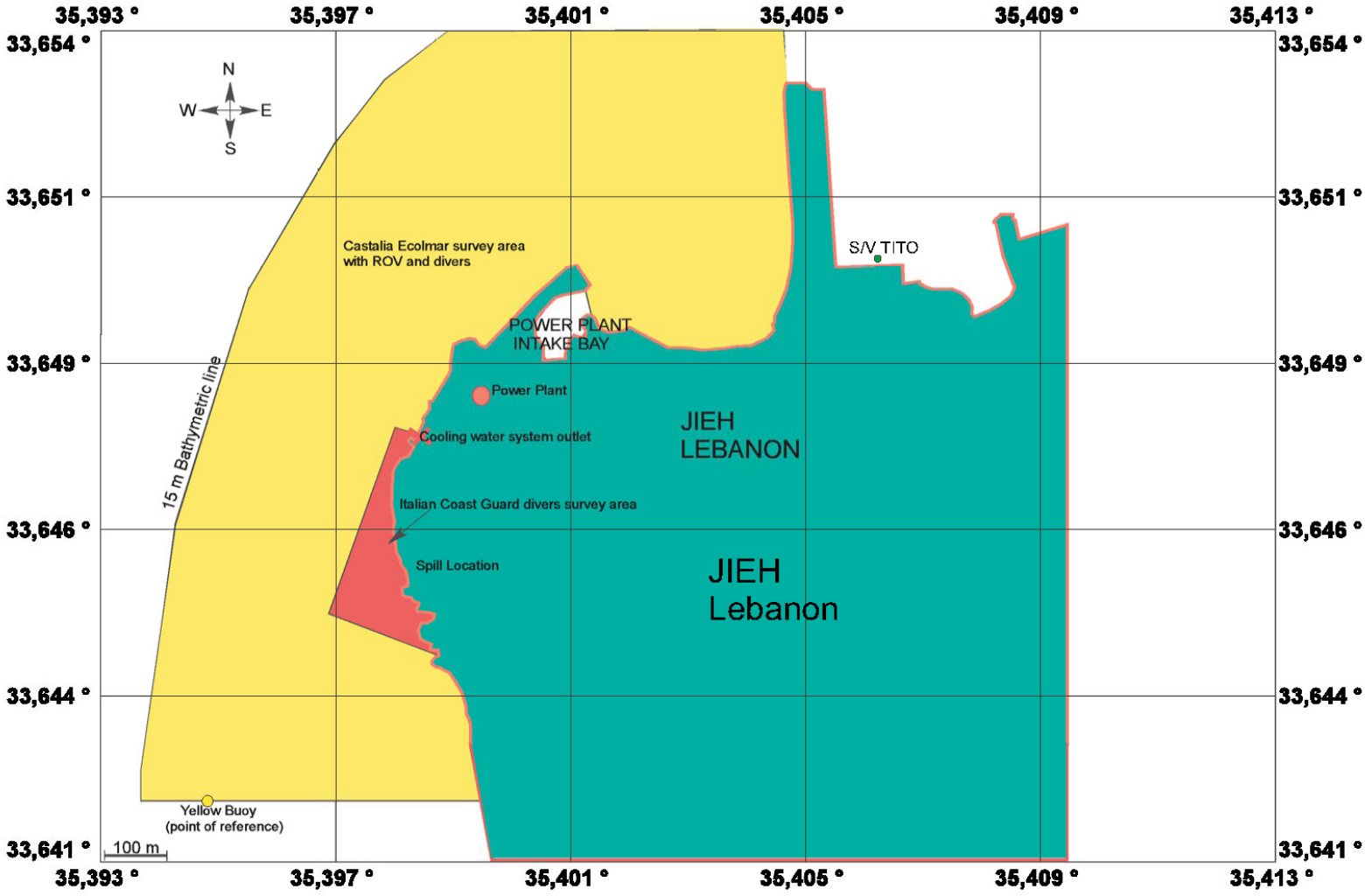
The offshore area has been surveyed by the Italian Ministry of Environment-Castalia Ecolmar with ROV system and divers.

THE FIRST AREA INTERESTED BY THE SURVEY
INTAKE BAY



MAP 1

THE SECOND AREA INTERESTED BY THE SURVEY



MAP 2

3. TECHNIQUES

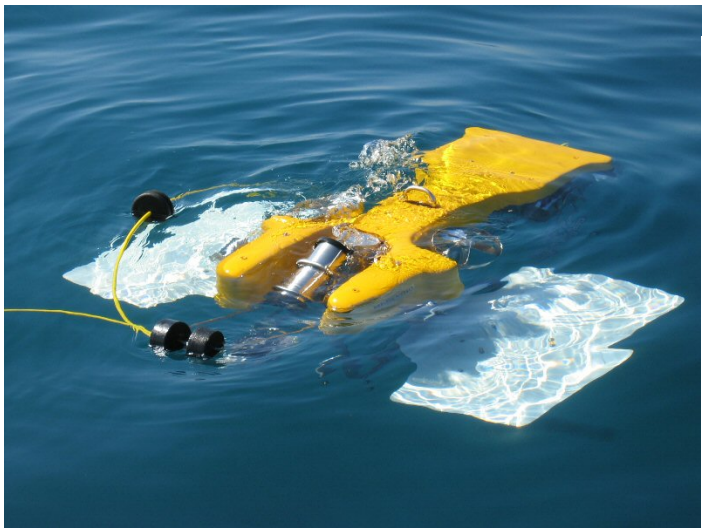
For the identification of the areas with the major concentration of hydrocarbons two different techniques have been utilised:

- the first one performed with R.O.V. (Remote Operated Vehicle).
- the second one conducted by divers inspections

The inspection activities have been adapted to the depth of the survey area, in particular Castalia Ecolmar performed the foreseen survey with:

- a towed ROV to cover big extensions with a sufficient depth
- a smaller cable driven ROV for the shallow and rocky areas
- direct inspections with divers for the individuation of the possible areas with presence of hydrocarbons covered by sand.

All the surveys have been recorded on a DVD support and all the visual documentation contains the position obtained by GPS to facilitate the realization of the thematic maps produced.



TOWED ROV MERCURIO

CABLE DRIVEN ROV PROMETEO

4. TYPOLOGY OF HYDROCARBONS RESIDUES INDIVIDUATED AND GENERAL CONSIDERATIONS

The form of oil residues found on the sea bottom can be basically divided in the following typologies:

- Solid (figure 1)
- semi-solid (figure 2)
- semi-liquid (figure 3)

Figure 2– Solid residues

Figure 3– Semi–solid residues

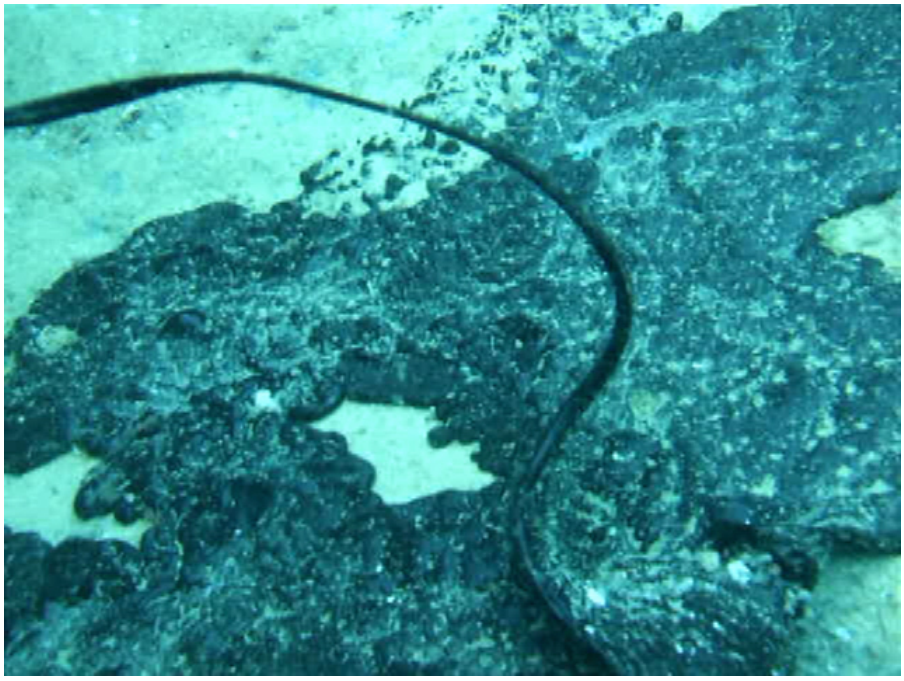


Figure 4– semi - liquid residues

5. SURVEY ACTIVITY

The survey activity with ROV has been conducted from the 24th September 2006 to the 8th October 2006.

A final period from the 11th to the 13th October 2006 has been dedicated to the divers verification of the presence of hydrocarbons covered by sand.

The survey activity with ROV interested 12 particular areas called with the letter from A to N.

The survey activities with ROV, in the above-mentioned period, are resumed in the table 1.

Date	Area (m2)	Survey place	Meteorological condition	ROV utilised	Area
24-sept	1.500	Intake Bay	SW 4	Rov Prometeo	A
25-sept	0		SW 4/5		
26-sept	756	Power plant area	SW 4/5	Rov mercurio	B
27-sept	10.150	Power plant area	N 6	Rov Prometeo	C
28-sept	27.650	Power plant area	N 6	Rov Prometeo	D
29-sept	15.400	Power plant area	N5	Rov Prometeo	E
30-sept	0		S 4		
01-oct	0		SW 4		
02- oct	78.000	Power plant area	SW 3	Rov Mercurio	F
03- oct	55.000	Power plant area	calm	Rov Mercurio	G
04- oct	59.900	Power plant area	calm	Rov Mercurio	H
05- oct	120.100	Power plant area	NW 3	Rov Mercurio	I
06- oct	52.000	Power plant area	NE 3	Rov Mercurio	L
07- oct	100.000	Power plant area	calm	Rov Mercurio	M
08- oct	175.000	Bay near the Sibline dock	calm	Rov Mercurio	N
Total area surveyed	**695.456 m^2**				

Table 1

6. AREA SURVEYED

6.1. FIRST AREA SURVEYED

AREA A

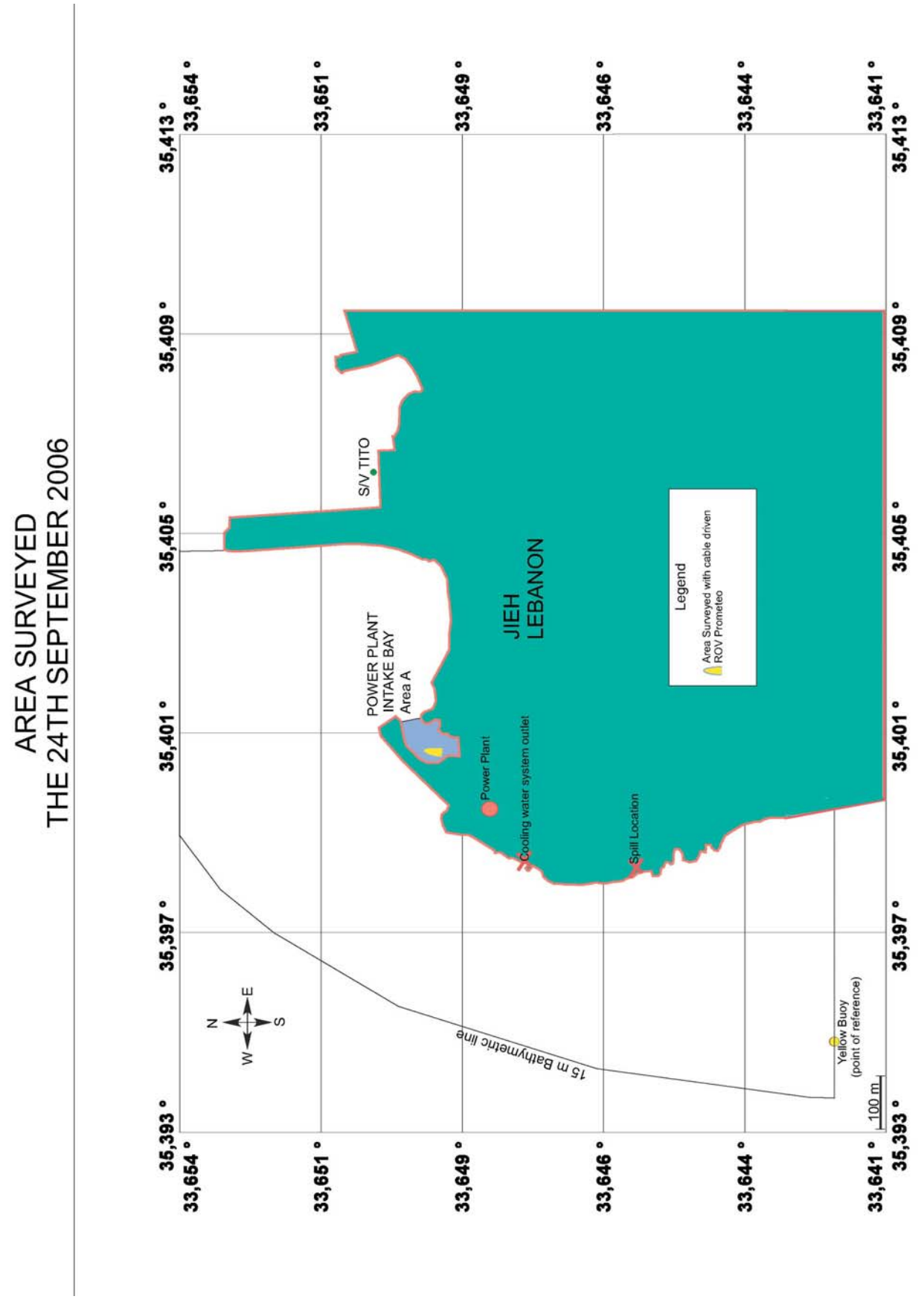
The characteristics of first area surveyed are:

- Surface survey: about 1.500 m2
- Bottom type: fine sand and rocks

The power plant intake and its grid have been surveyed.

Low presence of hydrocarbons residues in this area.

The area surveyed is represented in the following map:


AREA SURVEYED
THE 24TH SEPTEMBER 2006
35,413 °
33,654 °
33,651 °
33,649 °
33,646 °
33,644 °
33,641 °
35,409 °
35,405 °
35,401 °
35,397 °
35,393 °
S/V TITO
POWER PLANT
INTAKE BAY
Area A
JIEH
LEBANON
Power Plant
Cooling water system outlet
Spill Location
Legend
Area Surveyed with cable driven ROV Prometeo
15 m Bathymetric line
Yellow Buoy
(point of reference)
100 m
N
E
S
W

MAP 3

6.2. SECOND AREA SURVEYED

AREA B

Surface survey: about 756 m^2
Bottom type: sand and rocks
Bathymetry: 4 m
Note: Absence of hydrocarbons residues in this area.

AREA C

Surface survey: about 10150 m^2
Bottom type: sand
Note: Absence of hydrocarbons residues in this area.

AREA D

Surface survey: 25.000 m^2
Bottom type: sand and cobbles
Note: Absence of hydrocarbons residues in this area.

AREA E

Surface survey: 12.000 m^2
Bottom type: sand
Note: Absence of hydrocarbons residues in this area.

AREA F

Surface survey: 78.000 m^2
Bottom type: sand and rocks
Note: Absence of hydrocarbons residues in this area.

AREA G

Surface survey: 55.000 m^2
Bottom type: sand
Note: Presence of hydrocarbons residues in 8 areas.

Area G points where hydrocarbons residues presence has been found:

G1

Depth:	8 m
Geographical coordinates:	N 33° 38’ 50,46” E 035° 23’ 46,21”
Type product:	solid
Bottom type:	sand

G2

Depth:	6 m
Geographical coordinates:	N 33° 38’ 48,54” E 035° 23’ 48,06”
Type product:	solid
Bottom type:	sand

G3

Depth:	5,5 m
Geographical coordinates:	N 33° 38’ 44,76” E 035° 23’ 47,52”
Type product:	semisolid
Bottom type:	sand

G4

Depth:	8 m
Geographical coordinates:	N 33° 38’ 46,41” E 035° 23’ 46,21”
Type product:	solid
Bottom type:	sand

G5

Depth:	8 m
Geographical coordinates:	N 33° 38’ 45,59” E 035° 23’ 46,54”
Type product:	semisolid
Bottom type:	sand

G6

Depth:	6 m
Geographical coordinates:	N 33° 38’ 49,686” E 035° 23’ 46,65”
Type product:	semisolid
Bottom type:	sand and rocks

G7

Depth:	9 m
Geographical coordinates:	N 33° 38’ 46,76” E 035° 23’ 45,93”
Type of product:	semisolid
Bottom type:	sand

G8

Depth:	13 m
Geographical coordinates:	N 33° 38’ 47,76” E 035° 23’ 40,58”
Type product:	solid - strewed blocks
Bottom type:	sand

AREA H

Surface survey: 59900 m^2
Bottom type: mainly sand
Note: Presence of hydrocarbons residues in 3 areas.

Area H points where hydrocarbons residues presence have been found:

H1
Depth: 12 m
Geographical coordinates: N 33° 38’ 41,52” E 035° 23’ 41,34”
Type product: solid
Bottom type: sand

H2
Depth: 12 m
Geographical coordinates: N 33° 38’ 46,53” E 035° 23’ 41,97”
Type product: semisolid
Bottom type: sand and rocks

H3
Depth: 9,8 m
Geographical coordinates: N 33° 38’ 43,50” E 035° 23’ 43,07”
Type product: solid
Bottom type: sand

AREA I

Surface survey: 120.100 m^2
Bottom type: sand
Note: Absence of hydrocarbons residues in this area.

AREA L

Surface survey: 52.000 m^2
Bottom type: sand and rocks
Note: Presence of hydrocarbons residues in 1 area.

Area L point where hydrocarbons residues presence have been found:

L1
Depth: 8,8 m
Geographical coordinates: N 33° 39’ 00,4” E 035° 23’ 56,9”
Type product: solid
Bottom type: sand

AREA M

Surface survey: 100.000 m^2
Bottom type: mainly sand
Note: Presence of hydrocarbons residues in 2 areas.

Area M points where hydrocarbons residues presence have been found:

M1

Depth:	13 m
Geographical coordinates:	N 33° 38’ 42,61” E 035° 23’ 40,91”
Type product:	solid
Bottom type:	sand

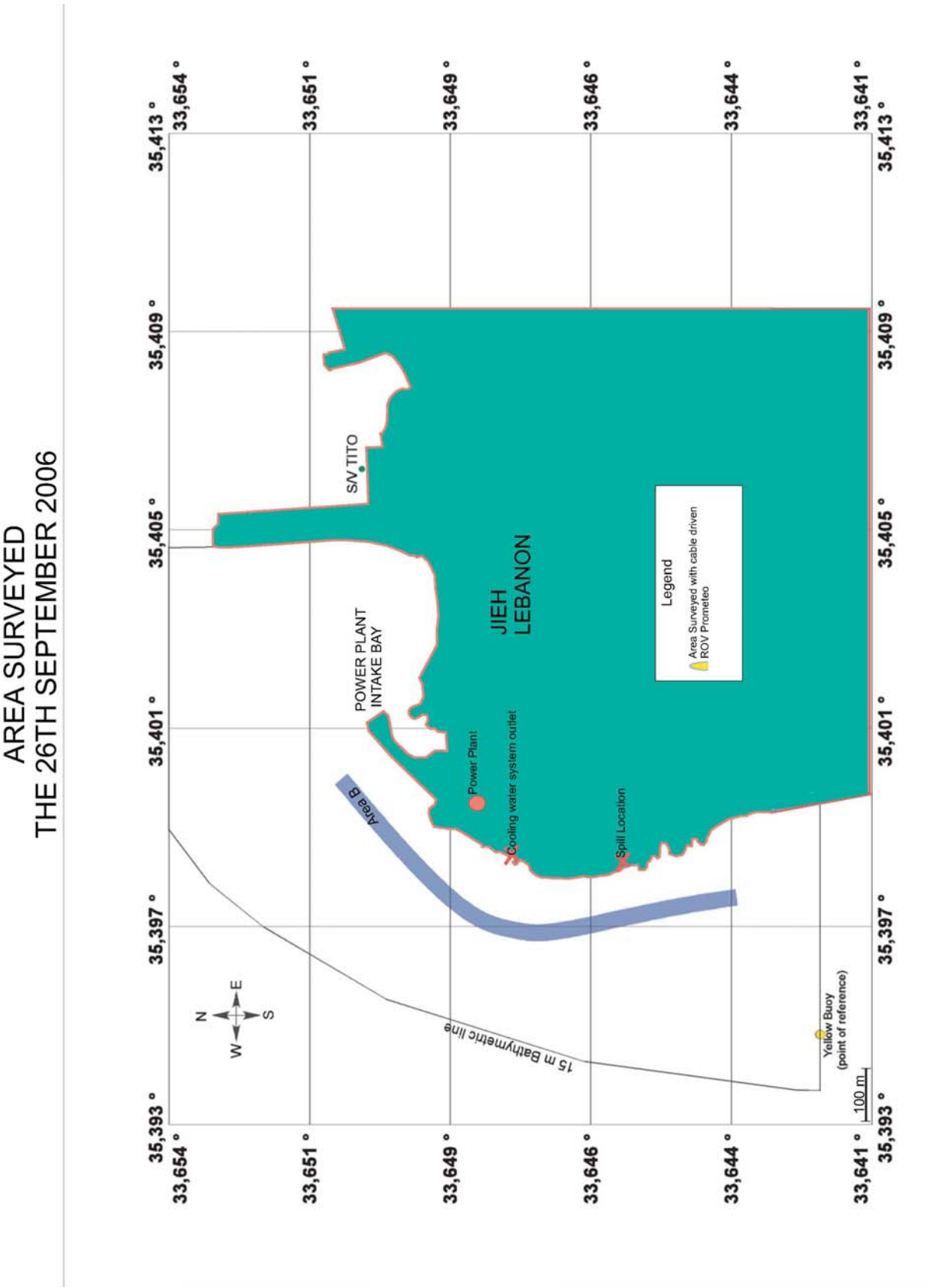
M2

Depth:	5,5 m
Geographical coordinates:	N 33° 38’ 48,68” E 035° 23’ 48,86”
Type product:	semisolid
Bottom type:	sand and rocks

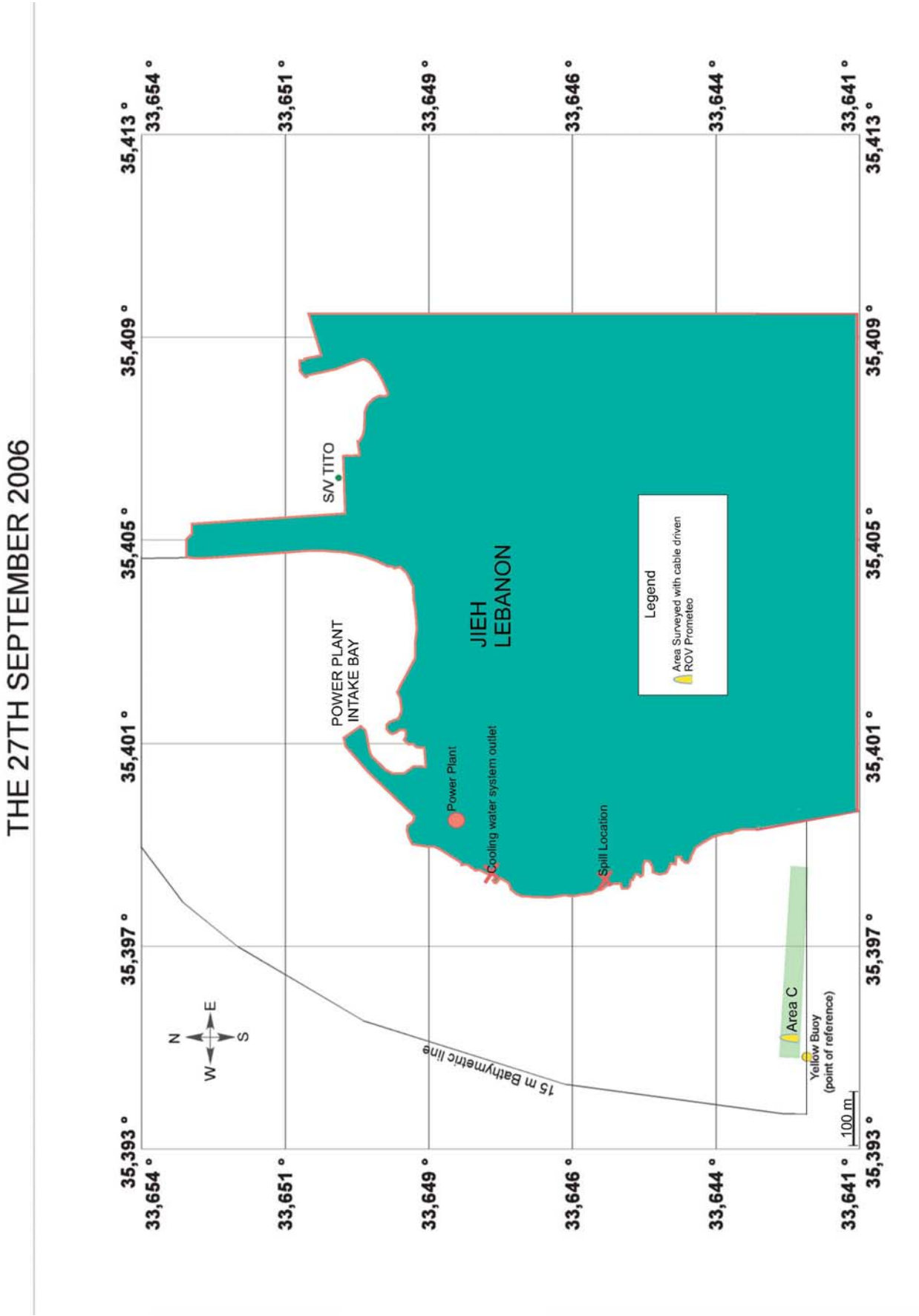
AREA N

Surface survey:	175.000 m^2
Bottom type:	sand and rocks
Note:	Absence of hydrocarbons residues in this area.

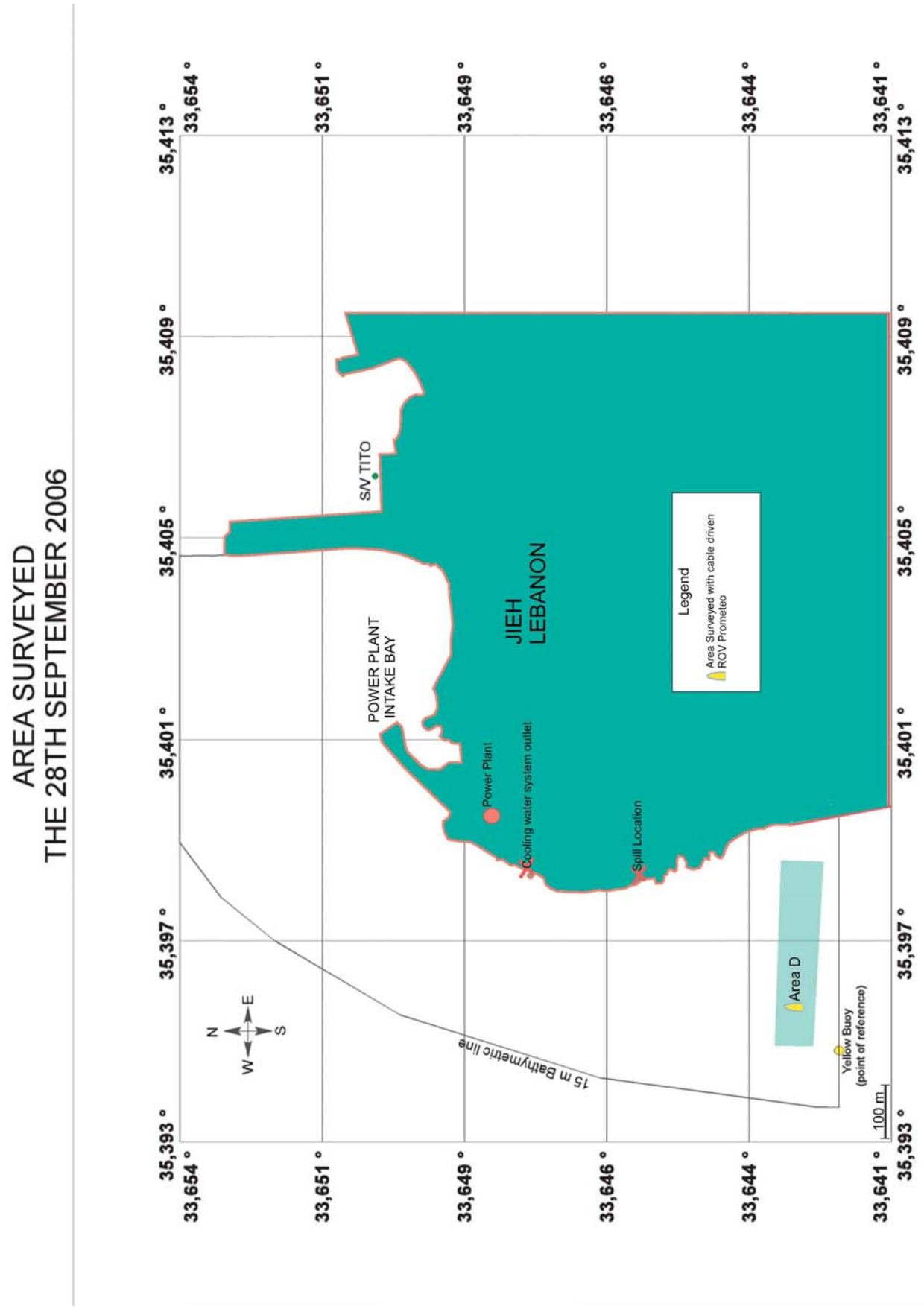
The areas surveyed are represented in the following maps:


AREA SURVEYED
THE 26TH SEPTEMBER 2006
35,413 °
33,654 °
33,651 °
33,649 °
33,646 °
33,644 °
33,641 °
35,409 °
35,405 °
35,401 °
35,397 °
35,393 °
S/V TITO
JIEH
LEBANON
POWER PLANT
INTAKE BAY
Power Plant
Cooling water system outlet
Spill Location
Area B
15 m Bathymetric line
Yellow Buoy
(point of reference)
100 m
N
S
E
W
Legend
Area Surveyed with cable driven
ROV Prometeo

Map 4

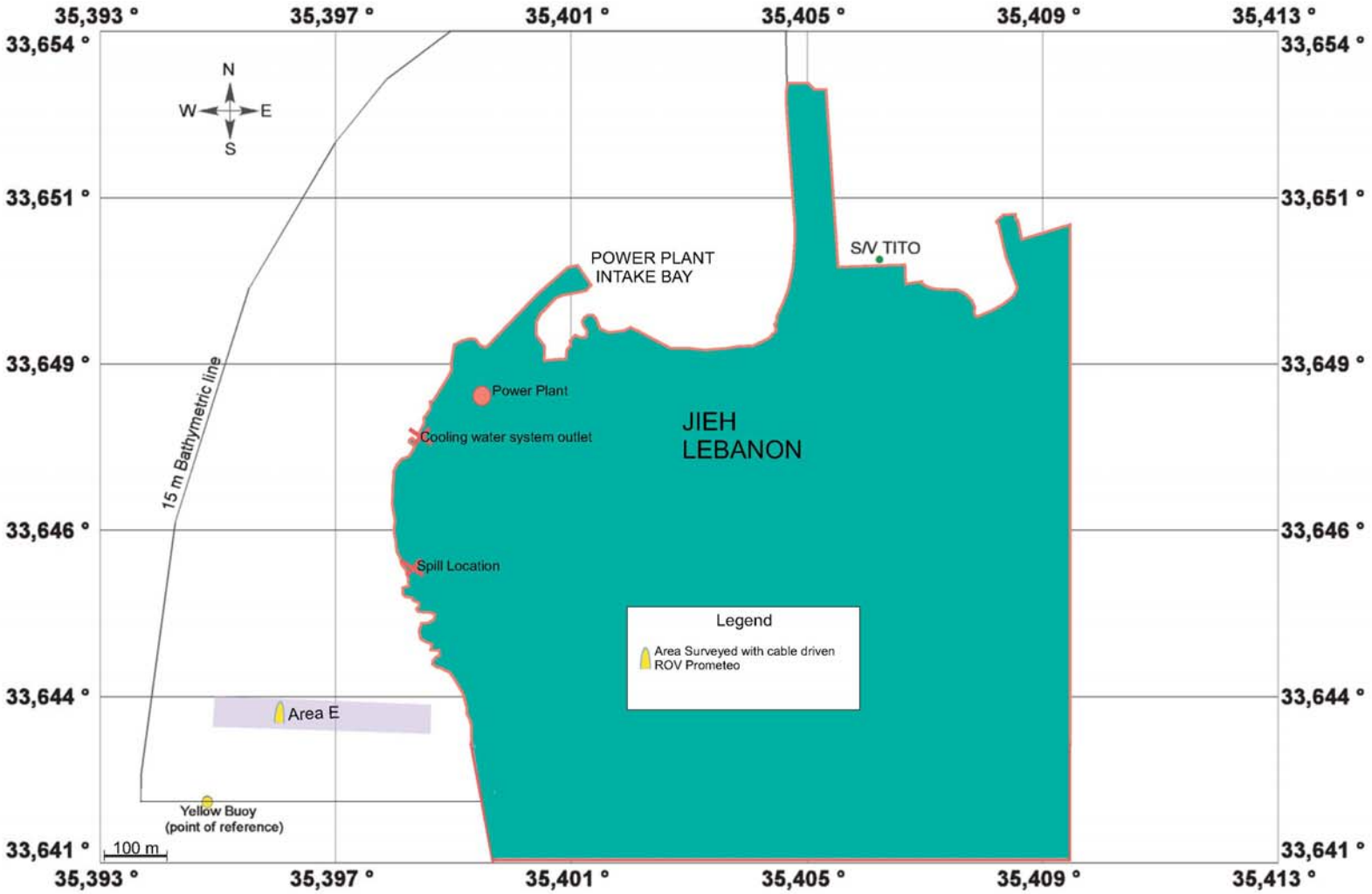

AREA SURVEYED
THE 27TH SEPTEMBER 2006
35,413 °
33,654 °
33,651 °
33,649 °
33,646 °
33,644 °
33,641 °
35,409 °
35,405 °
35,401 °
35,397 °
35,393 °
S/V TITO
POWER PLANT
INTAKE BAY
JIEH
LEBANON
Power Plant
Cooling water system outlet
Spill Location
Legend
Area Surveyed with cable driven ROV Prometeo
15 m Bathymetric line
Area C
Yellow Buoy
(point of reference)
100 m
N
E
S
W

Map 5

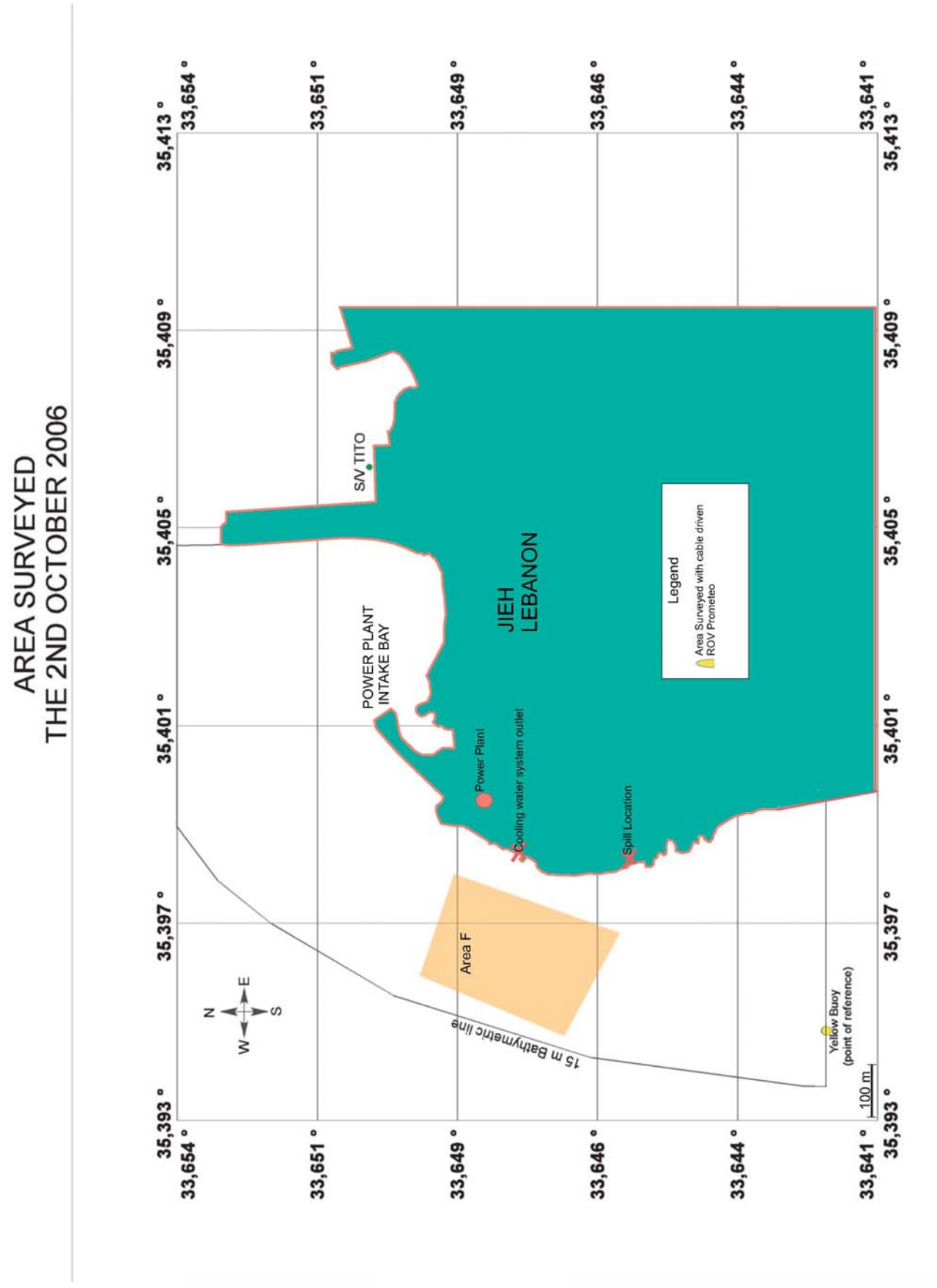

AREA SURVEYED
THE 28TH SEPTEMBER 2006
35,413 °
33,654 °
33,651 °
33,649 °
33,646 °
33,644 °
33,641 °
35,409 °
35,405 °
35,401 °
35,397 °
35,393 °
S/V TITO
POWER PLANT
INTAKE BAY
JIEH
LEBANON
Power Plant
Cooling water system outlet
Spill Location
Legend
Area Surveyed with cable driven
ROV Prometeo
Area D
Yellow Buoy
(point of reference)
15 m Bathymetric line
N
E
S
W
100 m

Map 6

AREA SURVEYED
THE 29TH SEPTEMBER 2006

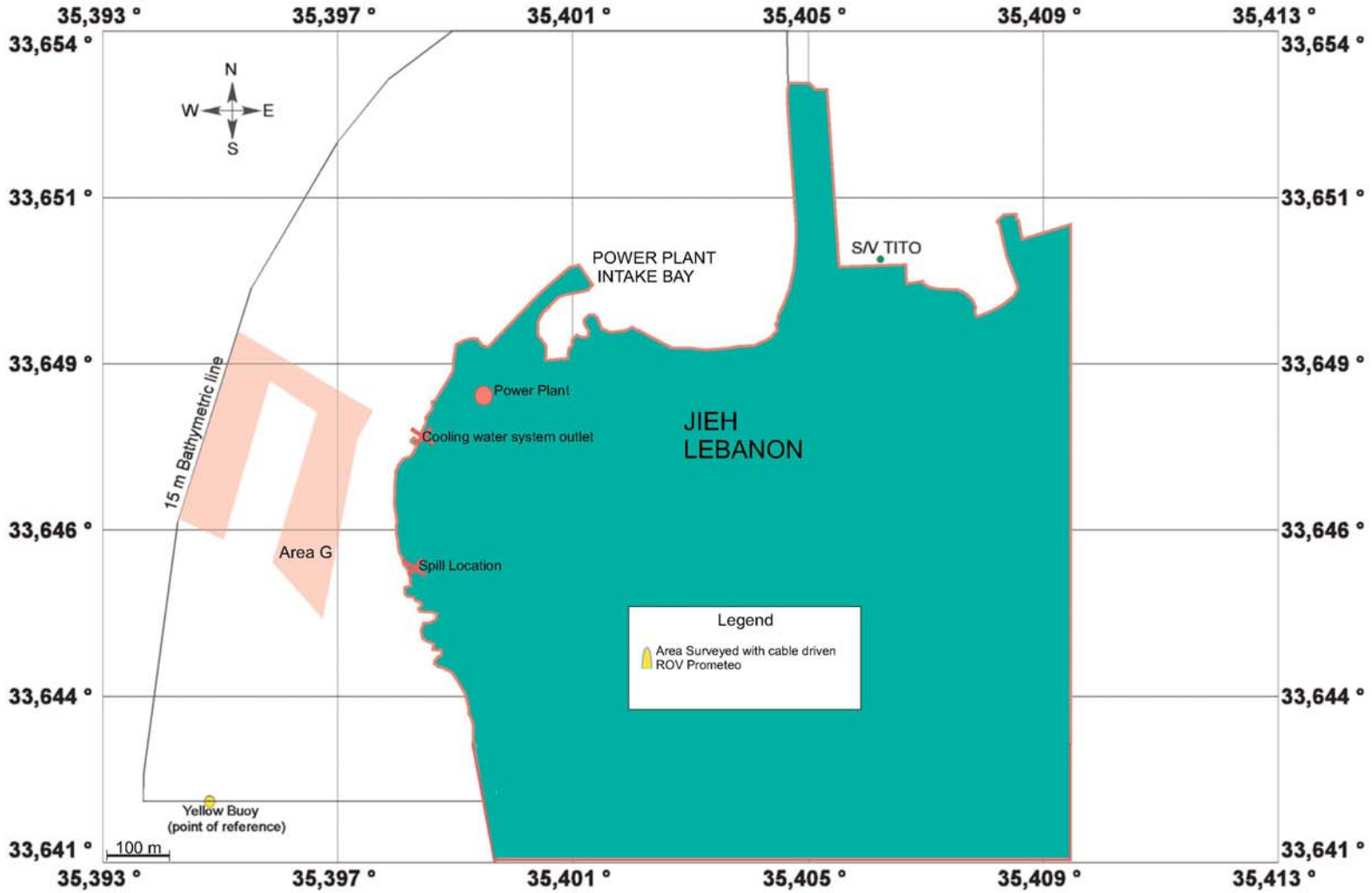


Map 7


AREA SURVEYED
THE 2ND OCTOBER 2006
35,413 °
33,654 °
33,651 °
33,649 °
33,646 °
33,644 °
33,641 °
35,409 °
35,405 °
35,401 °
35,397 °
35,393 °
S/V TITO
POWER PLANT
INTAKE BAY
JIEH
LEBANON
Power Plant
Cooling water system outlet
Spill Location
Area F
15 m Bathymetric line
Yellow Buoy
(point of reference)
100 m
N
E
S
W
Legend
Area Surveyed with cable driven
ROV Prometeo

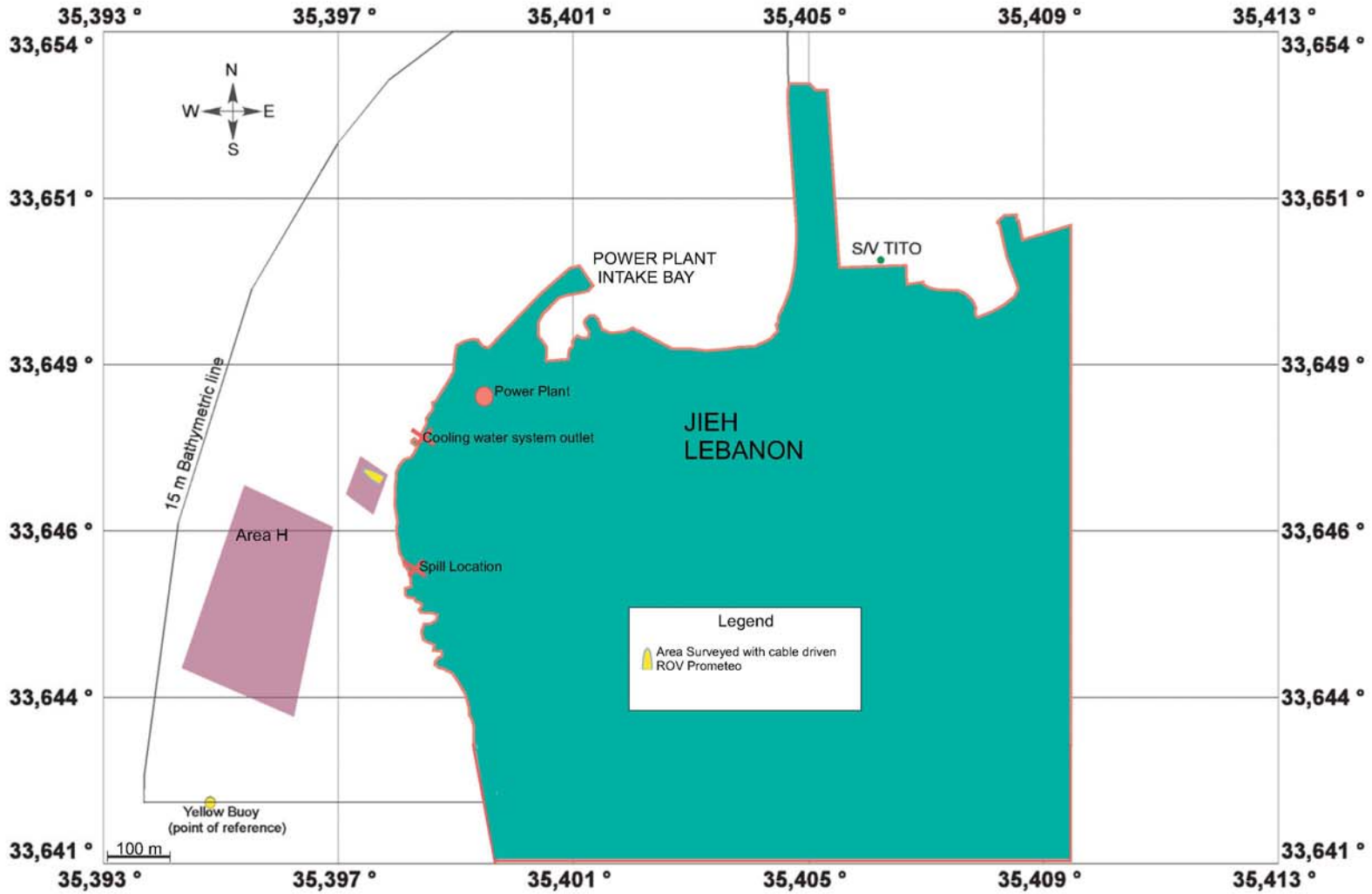
Map 8

AREA SURVEYED
THE 3rd OCTOBER 2006

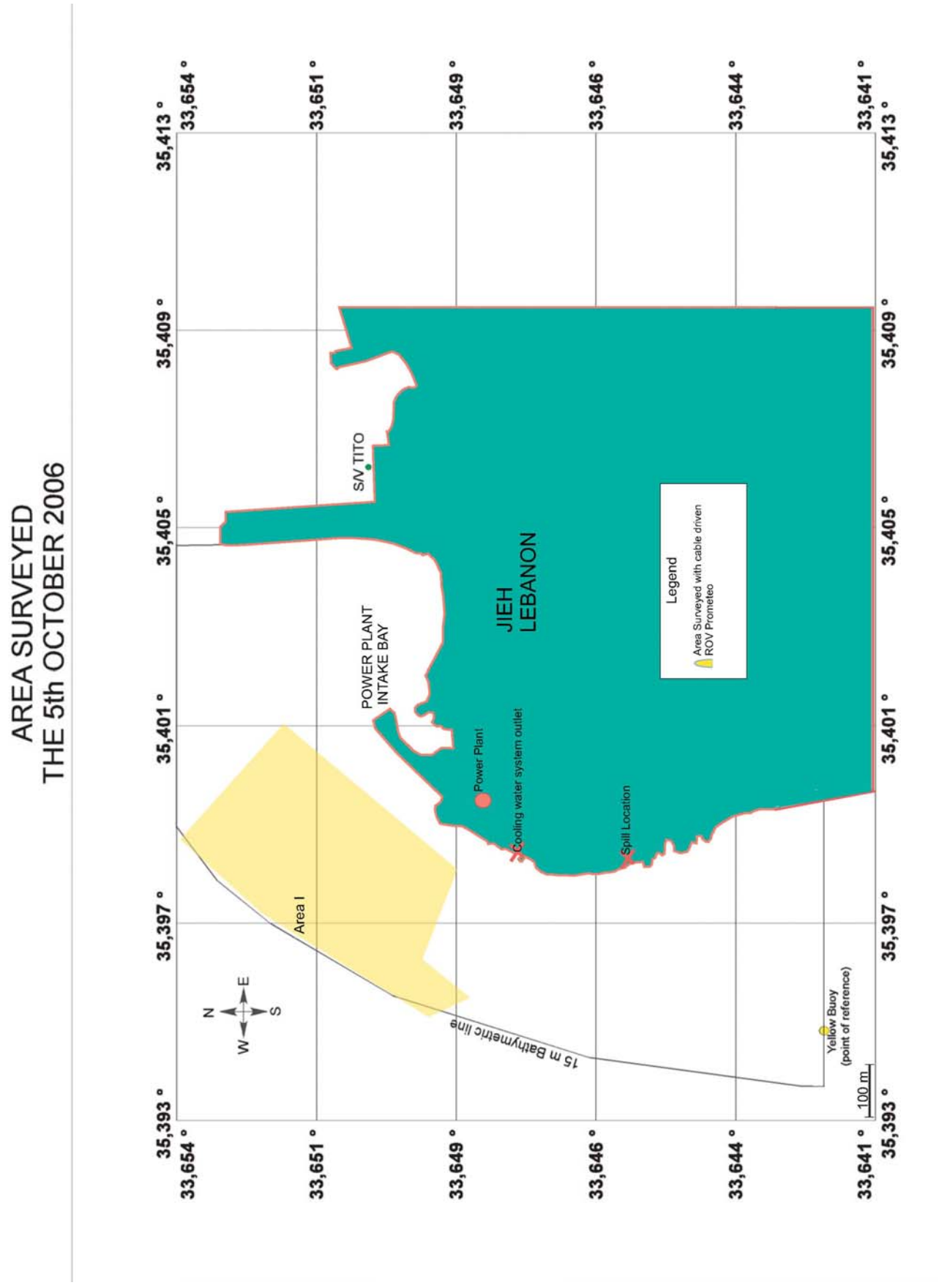


Map 9

AREA SURVEYED
THE 4th OCTOBER 2006

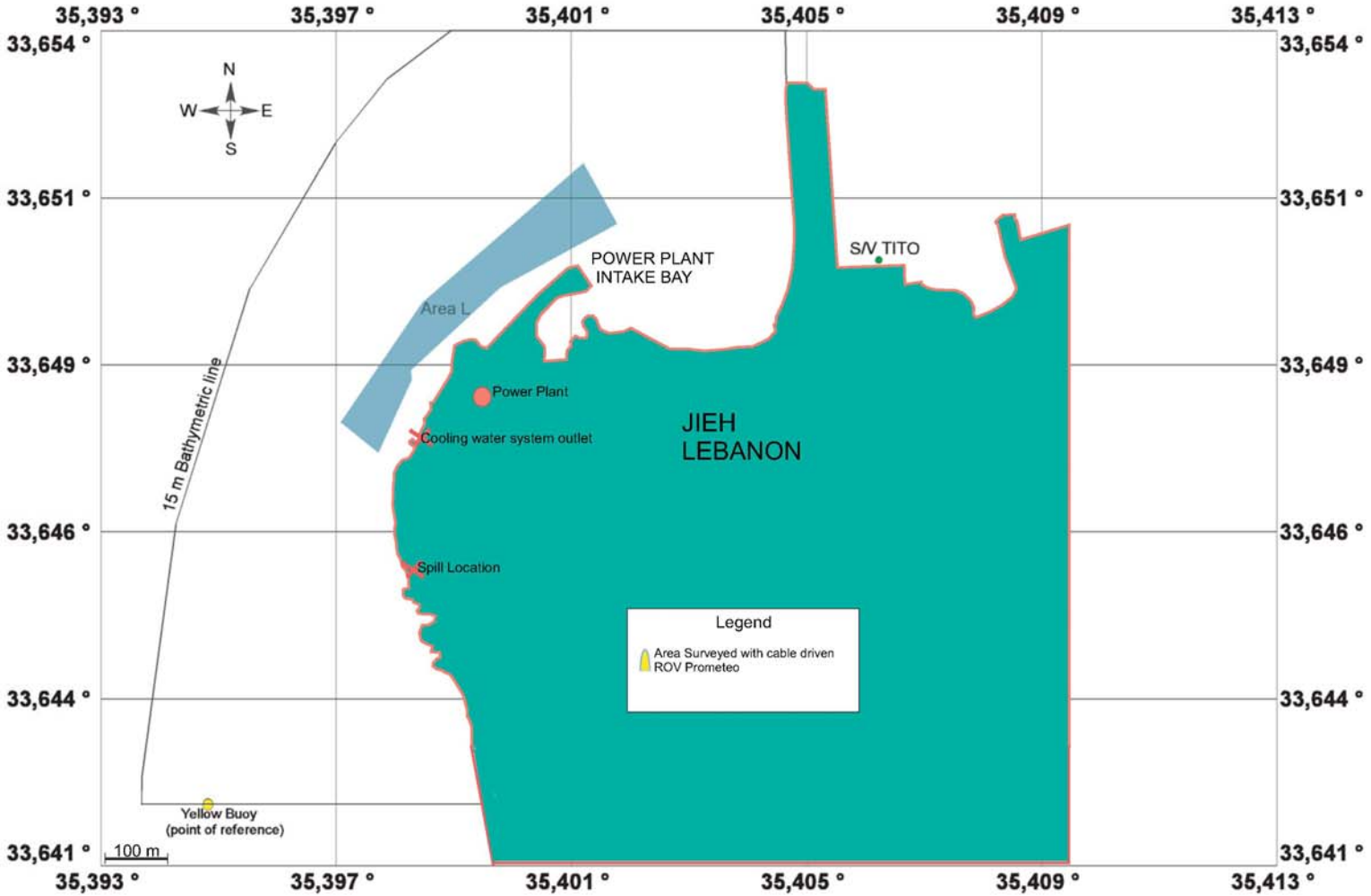


Map 10


AREA SURVEYED
THE 5th OCTOBER 2006
35,413 °
33,654 °
33,651 °
33,649 °
33,646 °
33,644 °
33,641 °
35,409 °
35,405 °
35,401 °
35,397 °
35,393 °
S/V TITO
POWER PLANT
INTAKE BAY
JIEH
LEBANON
Power Plant
Cooling water system outlet
Spill Location
Area I
15 m Bathymetric line
Yellow Buoy
(point of reference)
100 m
N
E
S
W
Legend
Area Surveyed with cable driven
ROV Prometeo

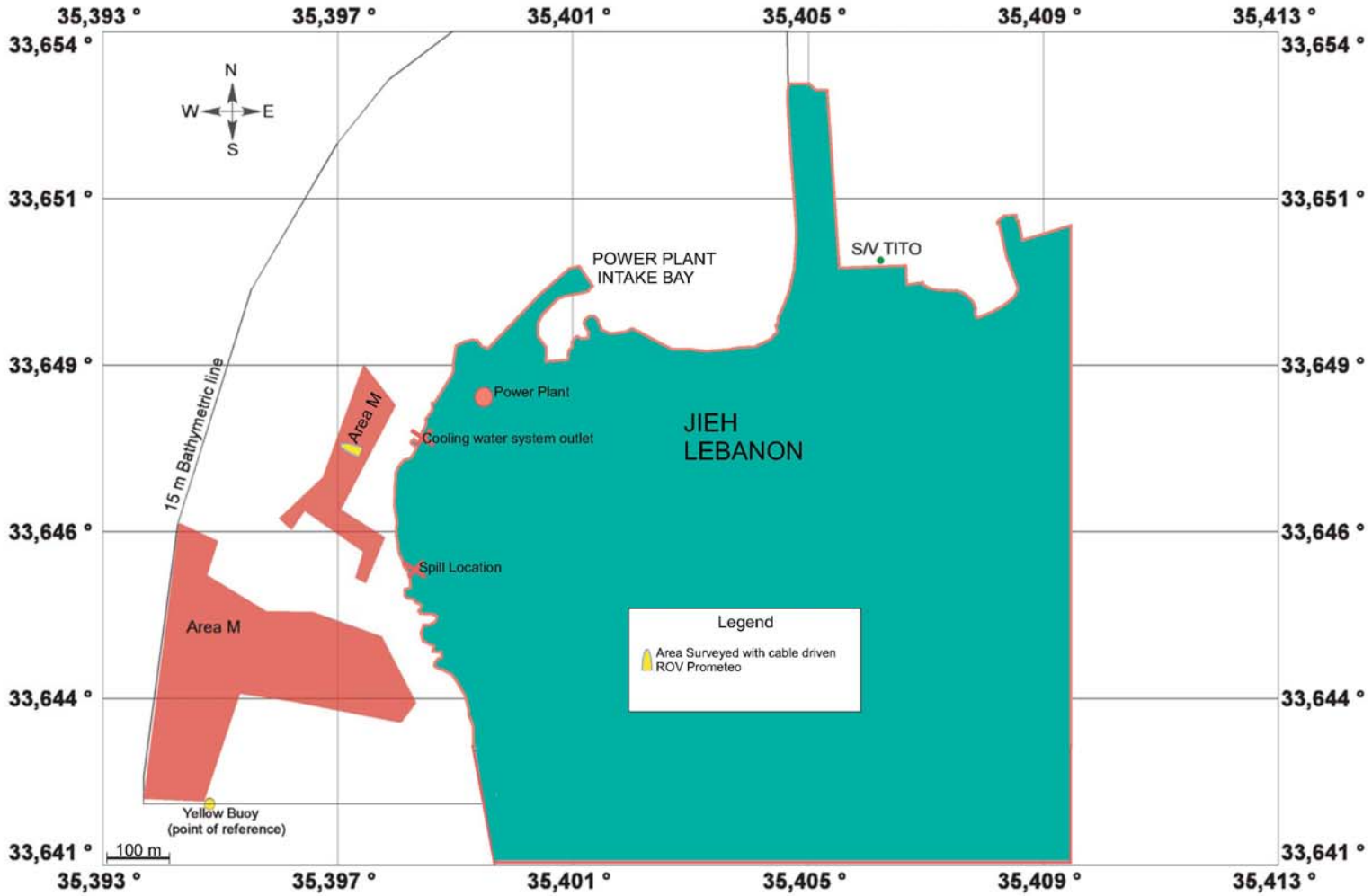
Map 11

AREA SURVEYED
THE 6th OCTOBER 2006



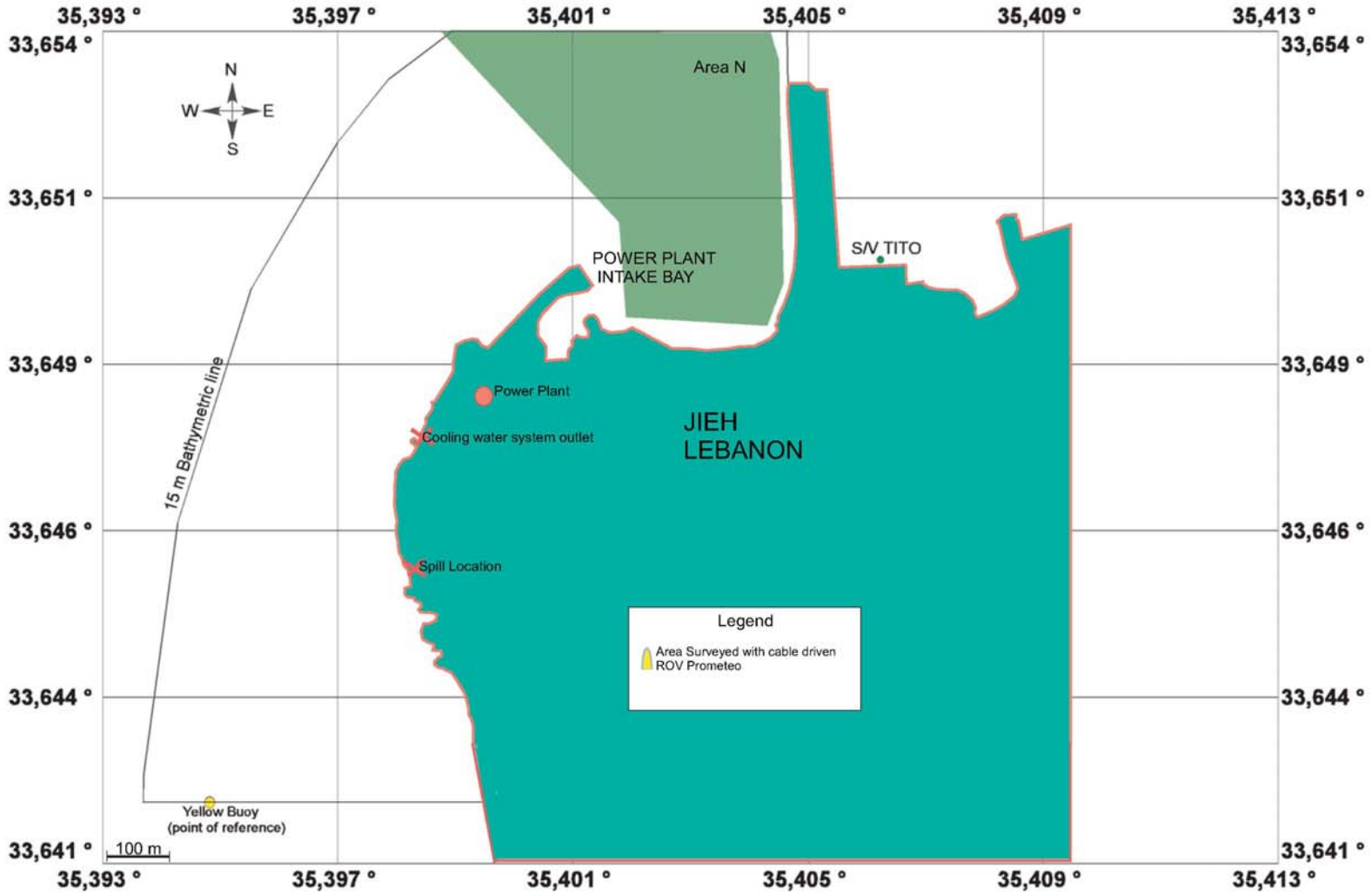
Map 12

AREA SURVEYED
THE 7th OCTOBER 2006

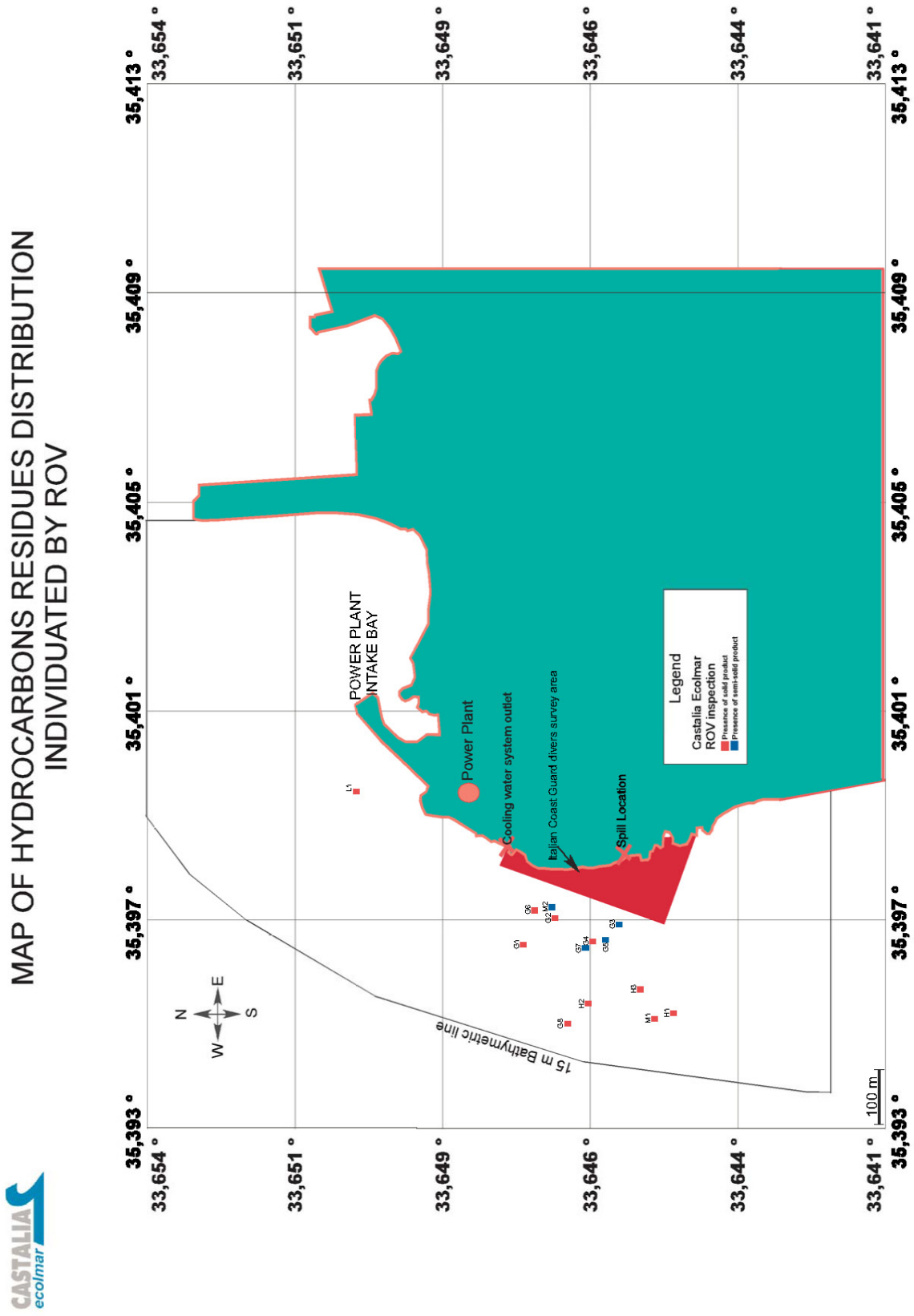


Map 13

AREA SURVEYED
THE 8th OCTOBER 2006



The output of survey by ROV is represented in the following map.

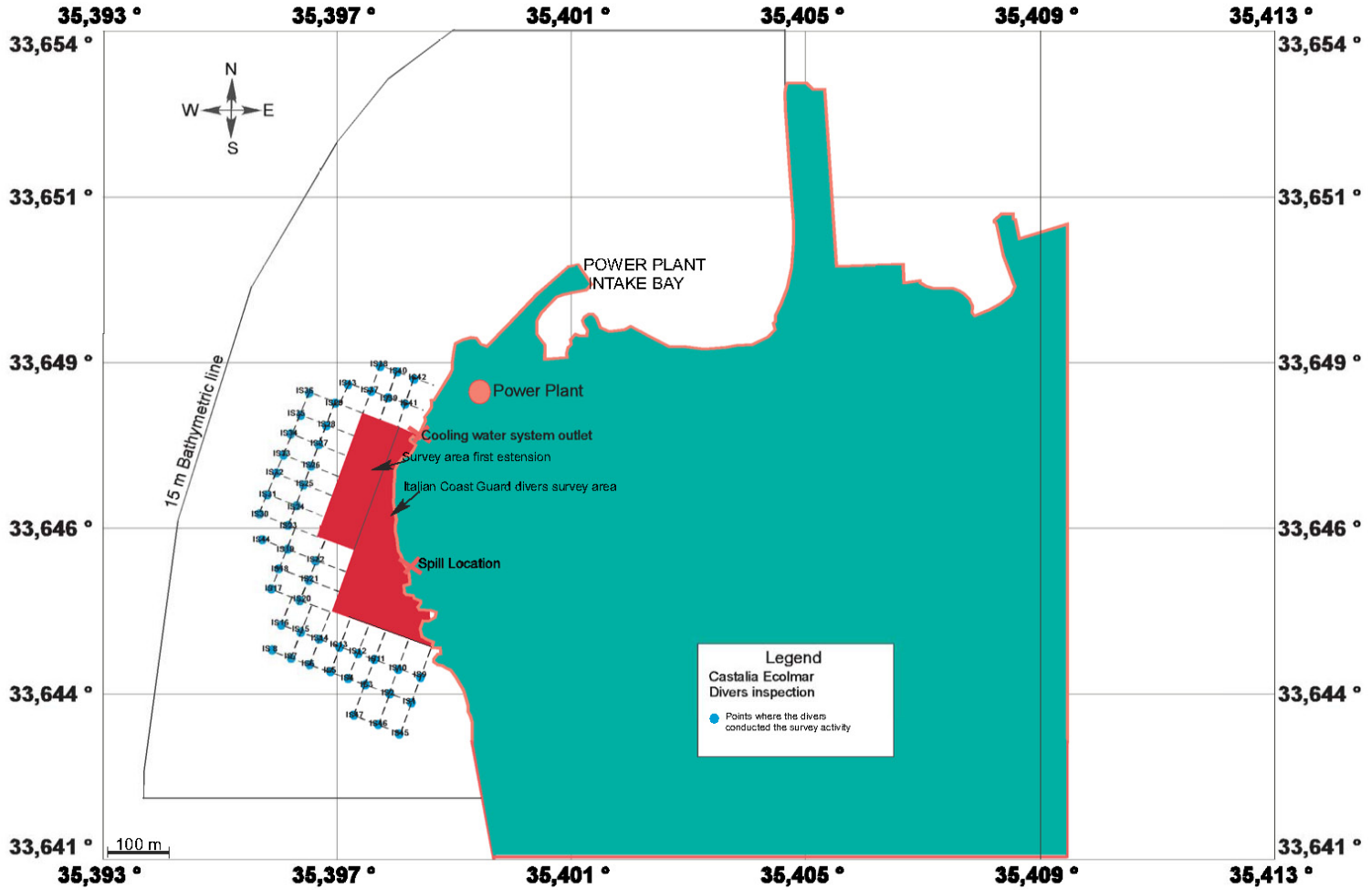


Map 15

7. SURVEY ACTIVITY WITH DIVERS

The period from the 11th to the 13th October 2006 has been dedicated to the divers verification of the presence of hydrocarbons covered by sand on the the areas represented in map 4.

MAP OF AREAS SURVEYED BY DIVERS



MAP 16

These points have been individuated at a distance of 50 - 100 m from the limit of the Italian coast guard survey area (see map 2).

Areas of about 1600 m^2, around the GPS individuated points, have been inspected, systematically investigating the presence of hydrocarbons over and under the sand.

The following criteria have been chosen to classify the inspected areas:

- *High presence* O: hydrocarbons residues distribution on the surface of the sea bottom (over and under the sand) more than the 50%, and thickness of the residues more than 10 cm.
- *Intermediate presence* O: hydrocarbons residues distribution on the surface of the bottom from 10 % to the 50 %, and thickness less than 10 cm.
- *Low presence* O*:* hydrocarbons residues distribution on the surface of the bottom less than 10 %, and thickness of the product not significant.
- *Absence* O: Absence of hydrocarbons residues in the area.

Point IS-1 O

- Bottom type: rocks
- Depth: 4,2 m
- *Hydrocarbons residues presence:*
  On sea bottom surface: Yes
  Covered by sand: No
- Type product: semisolid
- Product dimension: thickness from 5 to 30 mm.

Point IS-2 O

- Bottom type: rocks
- Depth: 6,4 m
- *Hydrocarbons residues presence:*
  On sea bottom surface: Yes
  Covered by sand: No
- Type product: semisolid
- Note: absence of hydrocarbons residues over the depth of 7,5 m

Point IS-3 O

- Bottom type: sand
- Depth: 6 m
- *Hydrocarbons residues presence:*
  On sea bottom surface: Yes
  Covered by sand: No
- Type product: solid
- Product dimension: 60 x 40 cm, thickness 20 cm

Point IS-4 O

- Bottom type: sand
- Depth: 6,1 m
- *Hydrocarbons residues presence:*
  On sea bottom surface: Yes –strewed particles
  Covered by sand: No

Point IS-5 O

- Bottom type: sand
- Depth: 6 m
- *Hydrocarbons residues presence:*
  On sea bottom surface: No
  Covered by sand: No

Point IS-6 O

- Bottom type: sand
- Depth: 7.9 m
- *Hydrocarbons residues presence*
  On surface bottom: No
  Covered by sand: No

Point IS-7 O

- Bottom type: sand
- Depth: 8 m
- *Hydrocarbons residues presence:*
  On sea bottom surface: No
  Covered by sand: No

Point IS-8 O

- Bottom type: sand
- Depth: 8.3 m
- *Hydrocarbons residues presence:*
  On sea bottom surface: No
  Covered by sand: No

Point IS-9 O

- Bottom type: rocks
- Depth: 4,2 m
- *Hydrocarbons residues presence:*
  On sea bottom surface: No
  Covered by sand: Yes- thickness about 20 cm
- Type product: semisolid
- Note: The thickness of the product increased in the coast direction

Point IS-10 O

- Bottom type: sand and rocks
- Depth: 4,7 m
- Hydrocarbons *residues presence:*
  On sea bottom surface: Yes
  Covered by sand: No
- Type product: semisolid

Point IS-11 O

- Bottom type: sand
- Depth: 5,7 m
- *Hydrocarbons residues presence:*
  On sea bottom surface: Yes
  Covered by sand: No

Point IS-12 O

- Bottom type: sand and rocks
- Depth: 9 m
- *Hydrocarbons* residues *presence:*
  On sea bottom surface: Yes – product mixed with sand
  Covered by sand: No

Point IS-13 O

- Bottom type: sand
- Depth: 6.1 m
- *Hydrocarbons* residues *presence:*
  On sea bottom surface: No
  Covered by sand: No

Point IS-14 O

- Bottom type: sand
- Depth: 6.6 m
- *Hydrocarbons* residues *presence:*
  On sea bottom surface: No
  Covered by sand: No

Point IS-15 O

- Bottom type: sand
- Depth: 7.1 m
- *Hydrocarbons* residues *presence:*
  On sea bottom surface: No
  Covered by sand: No

Point IS-16 O

- Bottom type: sand
- Depth: 8.5 m
- Hydrocarbons *residues presence:*
  On sea bottom surface: No
  Covered by sand: No

Point IS-17 O

- Bottom type: sand
- Depth: 9 m
- Hydrocarbons *residues presence:*
  On sea bottom surface: No
  Covered by sand: No

Point IS-18 O

- Bottom type: sand
- Depth: 8.4 m
- *Hydrocarbons* residues *presence:*
  On sea bottom surface: No
  Covered by sand: No

Point IS-19 O

- Bottom type: sand
- Depth: 8.6 m
- *Hydrocarbons residues presence:*

On sea bottom surface: No
Covered by sand: No

Point IS-20 O

- Bottom type: sand
- Depth: 7.8 m
- *Hydrocarbons* residues *presence:*
  On sea bottom surface: No
  Covered by sand: No

Point IS-21 O

- Bottom type: sand
- Depth: 7,8 m
- *Hydrocarbons residues presence:*
  On sea bottom surface: Yes - tarball mixed with sand
  Covered by sand: Yes – tarball mixed with sand and often covered by a sand thickness of 15 cm

Point IS-22 O

- Bottom type: sand
- Depth: 7,2 m
- *Hydrocarbons residues presence:*
  On sea bottom surface: Yes - tar ball mixed with sand
  Covered by sand: No

Point IS-23 O

- Bottom type: sand
- Depth: 9.4 m
- *Hydrocarbons residues presence:*
  On sea bottom surface: Yes – hydrocarbons product mixed with sand
  Covered by sand: No
- Product type: solid

Point IS-24 O

- Bottom type: sand
- Depth: 9,7 m
- *Hydrocarbons residues presence:*
  On sea bottom surface: Yes – hydrocarbons product mixed with sand
  Covered by sand: No
- Product type: solid

Point IS-25 O

- Bottom type: sand
- Depth: 8.6 m
- *Hydrocarbons residues presence:*

On sea bottom surface: No
Covered by sand: No

Point IS-26 O

- Bottom type: sand 20% - rocks 80%
- Depth: 7.2 m
- *Hydrocarbons residues presence:*
  On sea bottom surface: No
  Covered by sand: No

Point IS-27 O

- Bottom type: rocks
- Depth: 8.2 m
- *Hydrocarbons residues presence:*
  On sea bottom surface: No
  Covered by sand: No

Point IS-28 O

- Bottom type: rocks
- Depth: 7.8 m
- *Hydrocarbons residues presence:*
  On sea bottom surface: No
  Covered by sand: No

Point IS-29 O

- Bottom type: rocks
- Depth: 7.5 m
- *Hydrocarbons residues presence:*
  On sea bottom surface: No
  Covered by sand: No
- Note: sponges presence

figure 3 - Sponge

Point IS-30 O

- Bottom type: sand
- Depth: 8,7 m
- *Hydrocarbons residues presence:*
  On sea bottom surface: No
  Covered by sand: Yes – Hydrocarbons residues presence 5 cm under the sea bottom surface
- Product type: product mixed with sand
- Product dimension: 60x80 cm with thickness of 20 cm

Point IS-31 O

- Bottom type: rocks
- Depth: 10.4 m
- *Hydrocarbons residues presence:*
  On sea bottom surface: No
  Covered by sand: No
- Note: madrepore presence

Figura 1 - madrepore

Point IS-32 O

- Bottom type: rocks
- Depth: 10.2 m
- *Hydrocarbons residues presence:*
  On sea bottom surface: No
  Covered by sand: No

Point IS-33 O

- Bottom type: rocks
- Depth: 8.8 m
- *Hydrocarbons residues presence:*
  On sea bottom surface: No
  Covered by sand: No

Point IS-34 O

- Bottom type: rocks
- Depth: 8.7 m
- *Hydrocarbons residues presence:*
  On sea bottom surface: No
  Covered by sand: No

Point IS-35 O

- Bottom type: rocks
- Depth: 8.7 m
- *Hydrocarbons residues presence:*
  On sea bottom surface: No
  Covered by sand: No

Point IS-36 O

- Bottom type: rocks
- Depth: 8.9 m
- *Hydrocarbons residues presence:*
  On sea bottom surface: No
  Covered by sand: No

Point IS-37 O

- Bottom type: rocks
- Depth: 5,9 m
- *Hydrocarbons residues presence:*
  On sea bottom surface: Yes – compact block
  Covered by sand: No
- Product type: Solid

Point IS-38 O

- Bottom type: mainly rocks
- Depth: 8,2 m
- *Hydrocarbons residues presence:*
  On sea bottom surface: Yes – tarballs.
  Covered by sand: No

Point IS-39 O

- Bottom type: rocks
- Depth: 5.4 m
- *Hydrocarbons residues presence:*
  On sea bottom surface: No
  Covered by sand: No
- Note: calcareous material presence.

Point IS-40 O

- Bottom type: rocks
- Depth: 5.7 m
- *Hydrocarbons residues presence:*
  On sea bottom surface: No
  Covered by sand: No

Point IS-41 O

- Bottom type: rocks
- Depth: 4.4 m
- *Hydrocarbons residues presence:*
  On sea bottom surface: No
  Covered by sand: No

Point IS-42 O

- Bottom type: rocks
- Depth: 3.6 m
- *Hydrocarbons residues presence:*

On sea bottom surface: No
Covered by sand: No

Point IS-43 O

- Bottom type: rocks
- Depth: 7.7 m
- *Hydrocarbons residues presence:*
  On sea bottom surface: No
  Covered by sand: No

Point IS-44 O

- Bottom type: sand
- Depth: 10.5 m
- *Hydrocarbons residues presence:*
  On sea bottom surface: No
  Covered by sand: No

Point IS-45 O

- Bottom type: sand
- Depth: 7.2 m
- *Hydrocarbons residues presence:*
  On sea bottom surface: No
  Covered by sand: No

Point IS-46 O

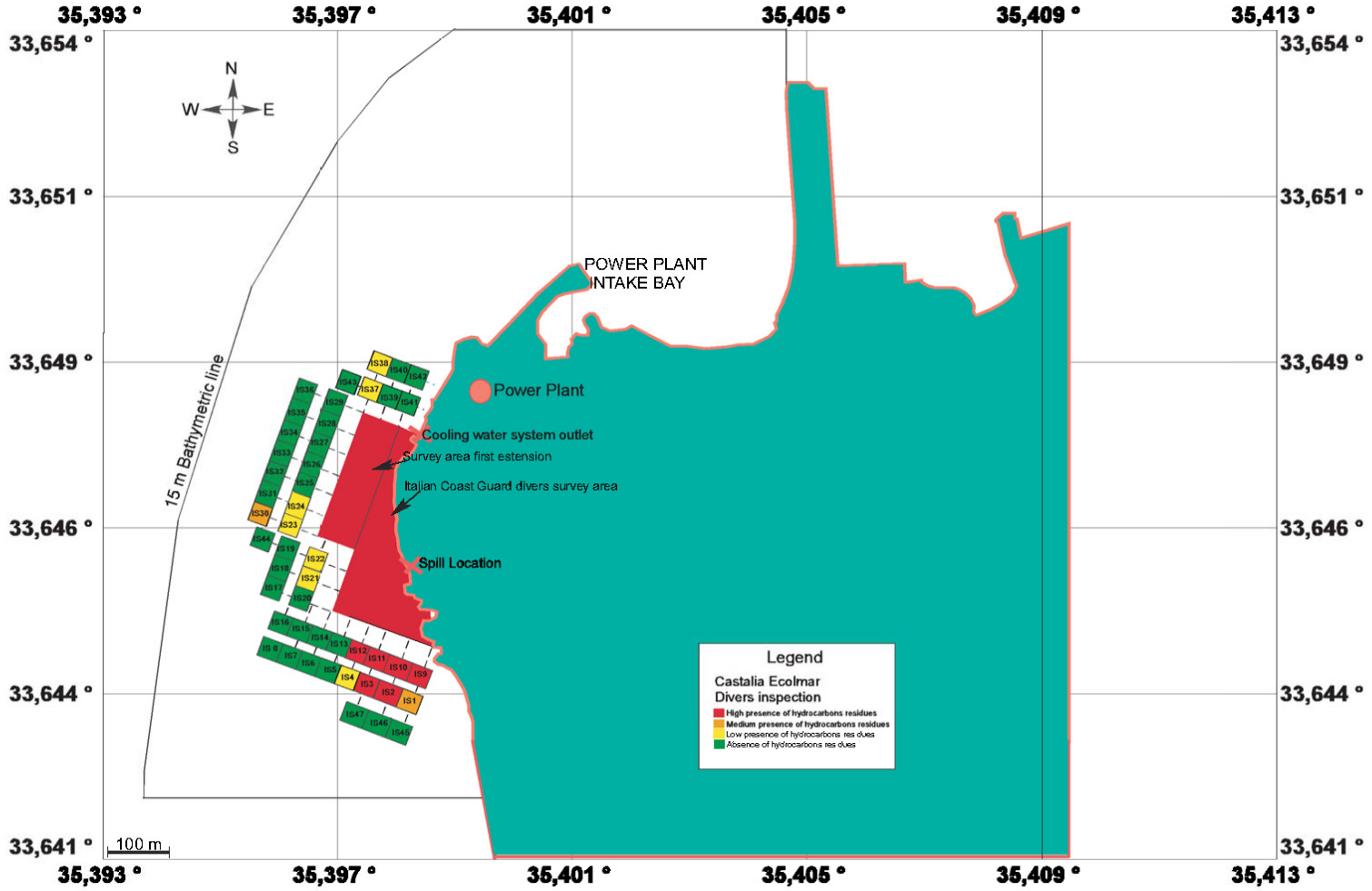
- Bottom type: sand
- Depth: 6.4 m
- *Hydrocarbons residues presence:*
  On sea bottom surface: No
  Covered by sand: No

Point IS-47 O

- Bottom type: sand
- Depth: 5.4 m
- *Hydrocarbons residues presence:*
  On sea bottom surface: No
  Covered by sand: No

The output of survey by Castalia Ecolmar divers is represented in the following map.

MAP OF HYDROCARBONS RESIDUES DISTRIBUTION INDIVIDUATED BY DIVERS



Map 17

8. CONCLUSIONS

From the analysis of the obtained results it appear evident that the major concentration of hydrocarbons is situated near the original point of the spill.

The particular morphology of the sea bottom have, in fact, naturally embanked the flow of the polluting material putting a mechanical obstacle with the submerged cliff.

Elevated quantity of solid hydrocarbons residues are present in the area near the power plant tanks, these residues are of elevate consistency.

The residues shows, moreover, combustion and rapid evaporation signs so to give to the residue itself a bubble structure.

The extension of the area interested by the major distribution of the hydrocarbons residues is of about 50.000 m^2.

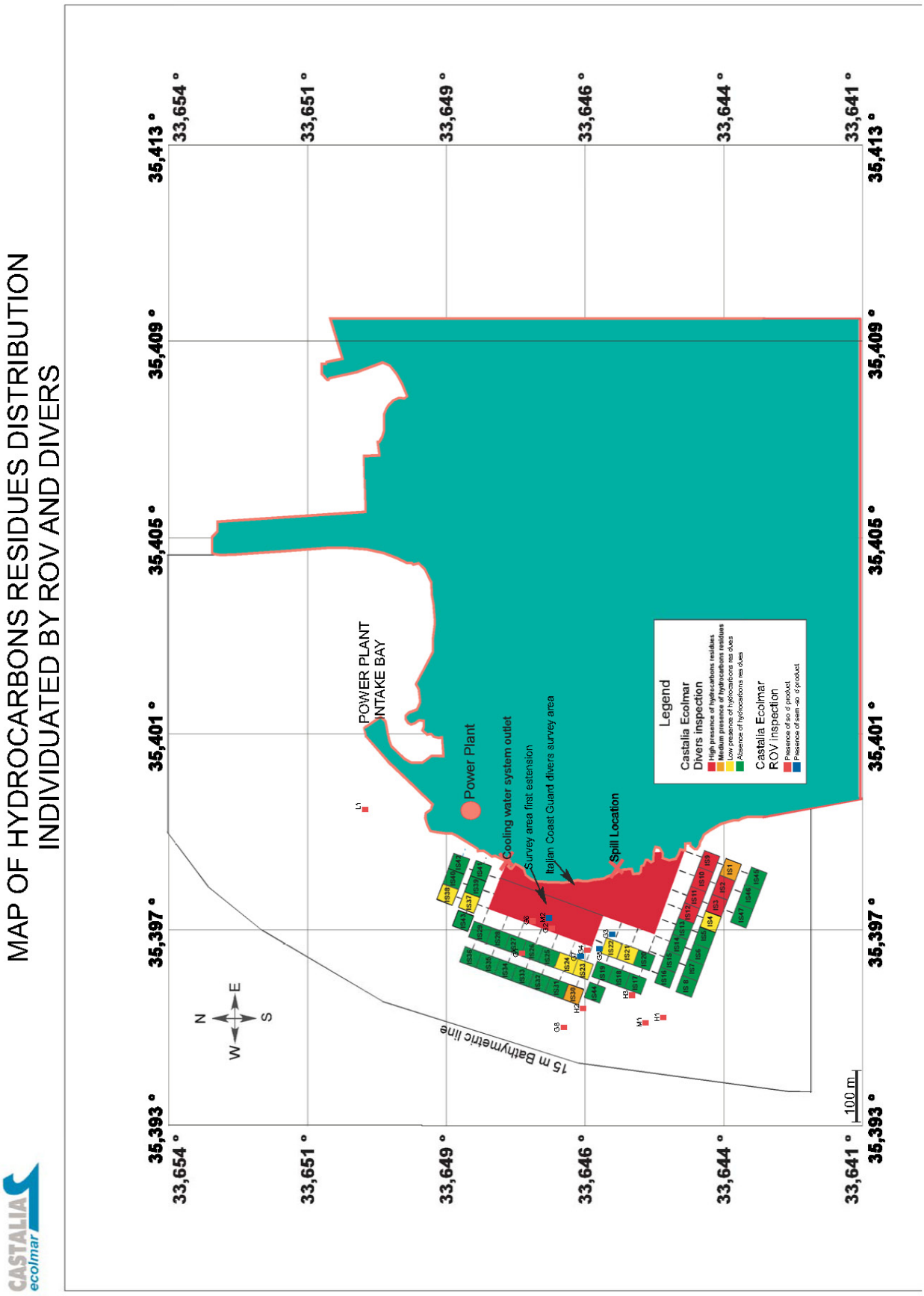
Inside the grid that has been realized, the product seems to have a clear gradient from South to North. In the Southern part is localised the more solid part of the residues, continuing to North the product become semisolid and at the end of the grid, semi – liquid.

Outside the grid very few areas have been interested by the spill as evident from the distribution maps.

The morphology of the area composed by cliffs, small caves present between the cliffs mixed with sandy bottoms brings to an objective difficulty in quantifying the product present in the area in absence of a three-dimensional equipment for the survey. Moreover this kind of equipment will be not easily applicable in the shallow water where the pollution is located.

It must be underlined that the fine sediment particles present in the area in association with the hydrodynamic energy due to currents and waves can cover or uncover on a daily base the observed residues.

The output of the survey activity carried out by Castalia Ecolmar is represented in the following map.


MAP OF HYDROCARBONS RESIDUES DISTRIBUTION
INDIVIDUATED BY ROV AND DIVERS
POWER PLANT
INTAKE BAY
Power Plant
Cooling water system outlet
Survey area first estension
Italian Coast Guard divers survey area
Spill Location
15 m Bathymetric line
Legend
Castalia Ecolmar
Divers inspection
High presence of hydrocarbons residues
Medium presence of hydrocarbons residues
Low presence of hydrocarbons residues
Absence of hydrocarbons residues
Castalia Ecolmar
ROV inspection
Presence of sea oil product
Presence of semi -sea oil product
N
S
E
W
100 m
35,413 °
35,409 °
35,405 °
35,401 °
35,397 °
35,393 °
33,654 °
33,651 °
33,649 °
33,646 °
33,644 °
33,641 °

Map 18

9. INTEGRATION WITH THE ITALIAN COAST GUARD SURVEY

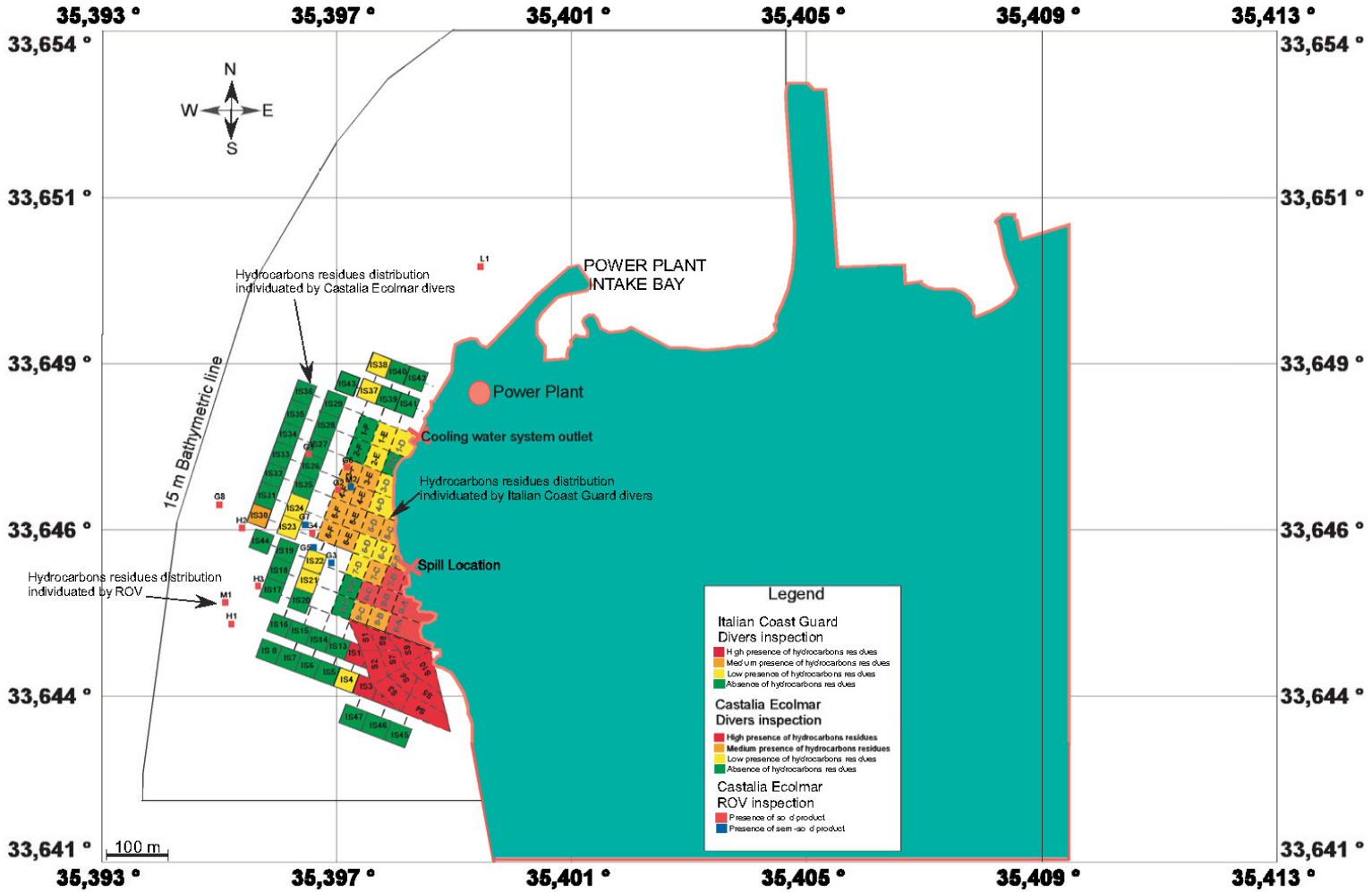
To complete the frame of the hydrocarbons residues distribution on the sea bottom, in map 19 the results are integrated with the ones obtained by the italian coast guard survey.

The criteria used by the Italian coast guard survey are qualitative and took in consideration the surface occupied from product for every area surveyed.

In particular the areas individuated have been classified in:

- *High concentration*: if the hydrocarbons presence has been detected in each cliff cave/surface inspected
- *Media concentration:* if the hydrocarbons presence has been detected in about 50% of the cliff cave/surface inspected
- *Low concentration:* if the hydrocarbons presence has been detected in less than 50 % of the cliff cave/surface inspected

MAP OF HYDROCARBONS RESIDUES DISTRIBUTION



Map 19

Ministero dell'Ambiente
e della Tutela del Territorio

CASTALIA ecolmar

CLEAN UP ACTIVITIES IN THE SEA FLOOR IN FRONT OF THE JIEH POWER PLANT

26/09/2006 – 02/11/2006

DOCUMENT CODE: RTE 11					
PROJECT: PRO 021					
DOCUMENT TITLE: CLEAN UP ACTIVITIES IN THE SEA FLOOR IN FRONT OF THE JIEH POWER PLANT - 26/09/2006 – 02/11/2006					
	16/11/2006		Trinci	Morucci	Arazzini
REV.	DATE	REVISION DESCRIPTION	COMPILED	VERIFIED	APPROVED

INDEX

1. Introduction

The aim of the present report is to present a synthesis of the remediation and decontamination plan and activities of the coastal area in front of the thermoelectric power station of Jieh (Lebanon), carried out from September 26th to November 2nd 2006, after the spill occurred in July 2006, underlining the main conclusions deriving from the experimental results of the operations.

Following the request of the Lebanese Ministry of Environment, the Italian Ministry of Environment asked Castalia Ecolmar, in the frame of the Italian mission, to intervene sending in the area of Jieh the antipollution vessel S/V Tito, with specific depth remediation equipment and a task force constituted by divers and oil spill response experts.

The task force has simultaneously started up the removal of hydrocarbons from the sea bottom of the areas in front of the power station tanks, in which the presence of submerged hydrocarbons was evident since the preliminary controls, and the survey of the overall area, carried out with ROV and divers (see survey report).

Successively, the general remediation prospect has been programmed on the basis of the results obtained.

2. General comments on Jieh remediation activities

For the starting up of the remediation activities the availability of an antipollution vessel with correct performances in shallow water conditions and of a temporary dumping area for the collected material were absolute priorities.
Concerning the availability of a landing place for the transitory storage of the material, on October 10 th , the Lebanese Ministry of Environment have formally communicated the possibility to utilize the dock of the “Ciment de Sibline” group in Jieh, from where the collected material had to be loaded on trucks, coordinated by the Lebanese Ministry, for the transport of wastes to the storage area individuated by the Ministry.

From that day, it has been possible to plan the arrival of the pontoon for the remediation activities.

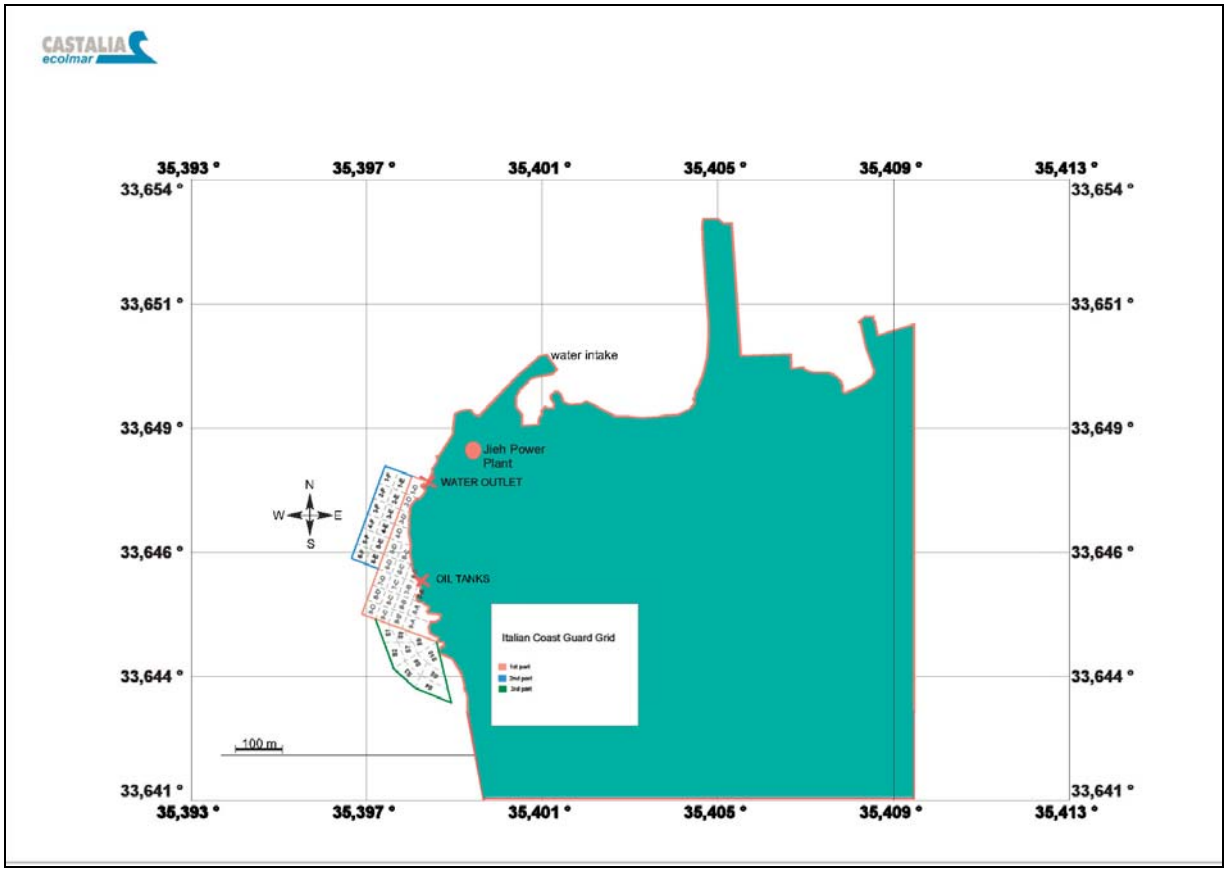
The pontoon, coming from Tripoli, has reached the operation area on October 13 rd 2006, and has been prepared in one working day.

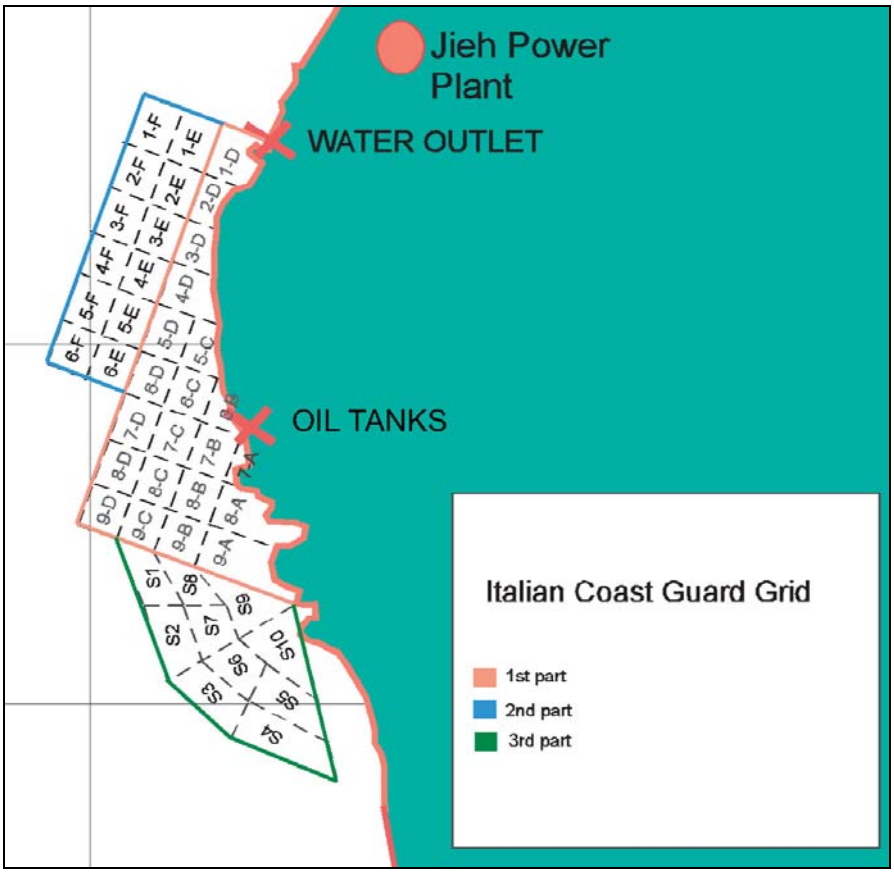
On October 14 th, it has been possible to start up the air suction pump testing it on the different typologies of products.

It is correct to underline that during the period October 14th – November 3rd (20 operational days) the activities were suspended for a considerable number of days, because of adverse weather conditions (see table 2).

3. Synthesis of the Jieh survey results

The Italian Coast Guard divers provided, in three different steps, the setting of a grid limited by buoys in the zone facing the spill area (from the water cooling system outlet to the south tanks zone - see Fig. 1a - 1 b) and carried out underwater inspections to verify the contamination level of the area.





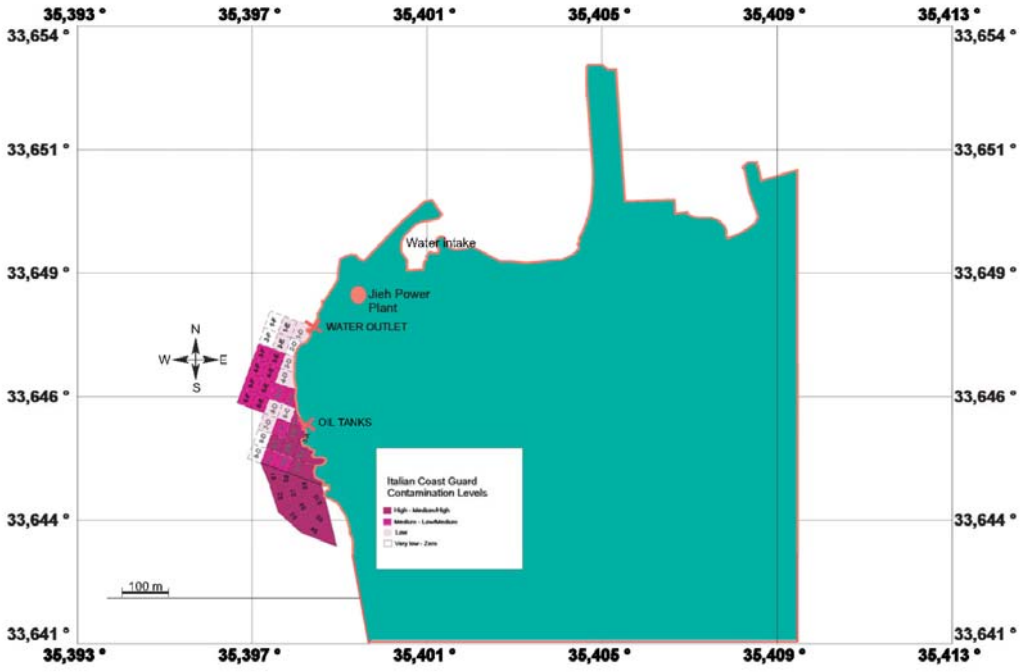
Figures 1a – 1b

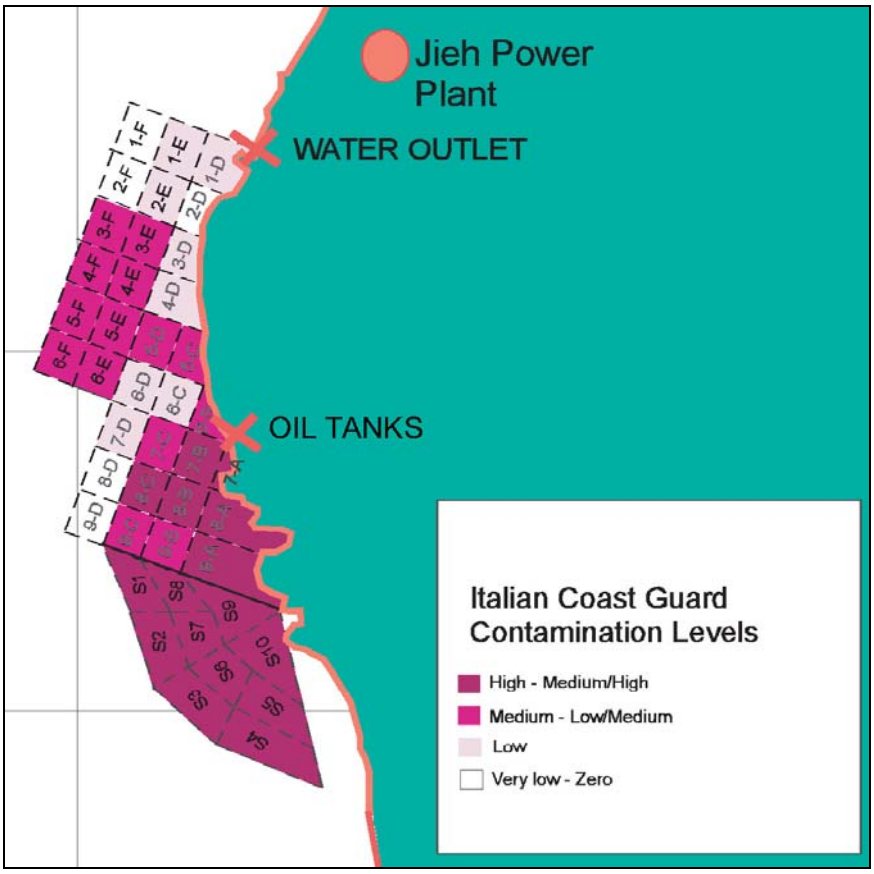
The cleaning up activities were performed in the area identified by the grid constituted by 33 cells of 30 meters of side and 10 cells located in the southern area, for a total surface of about 50.000 m^2 with maximum depth of about 7/8 metres.

The underwater surveys results provided by the Italian Coast Guard divers on the different individuated cells were resumed in a document that identifies the different levels of contamination of the area on the bases of the percentage of surface occupied by the pollutant products.

The criteria was chosen and the different areas were identified on a contamination basis (absent, very low, low, low/medium, medium, medium/high, high (fig. 2a – 2b)) after a bi-dimensional observation directed to the product distribution.

SEA FLOOR CONTAMINATION CHARACTERISTICS



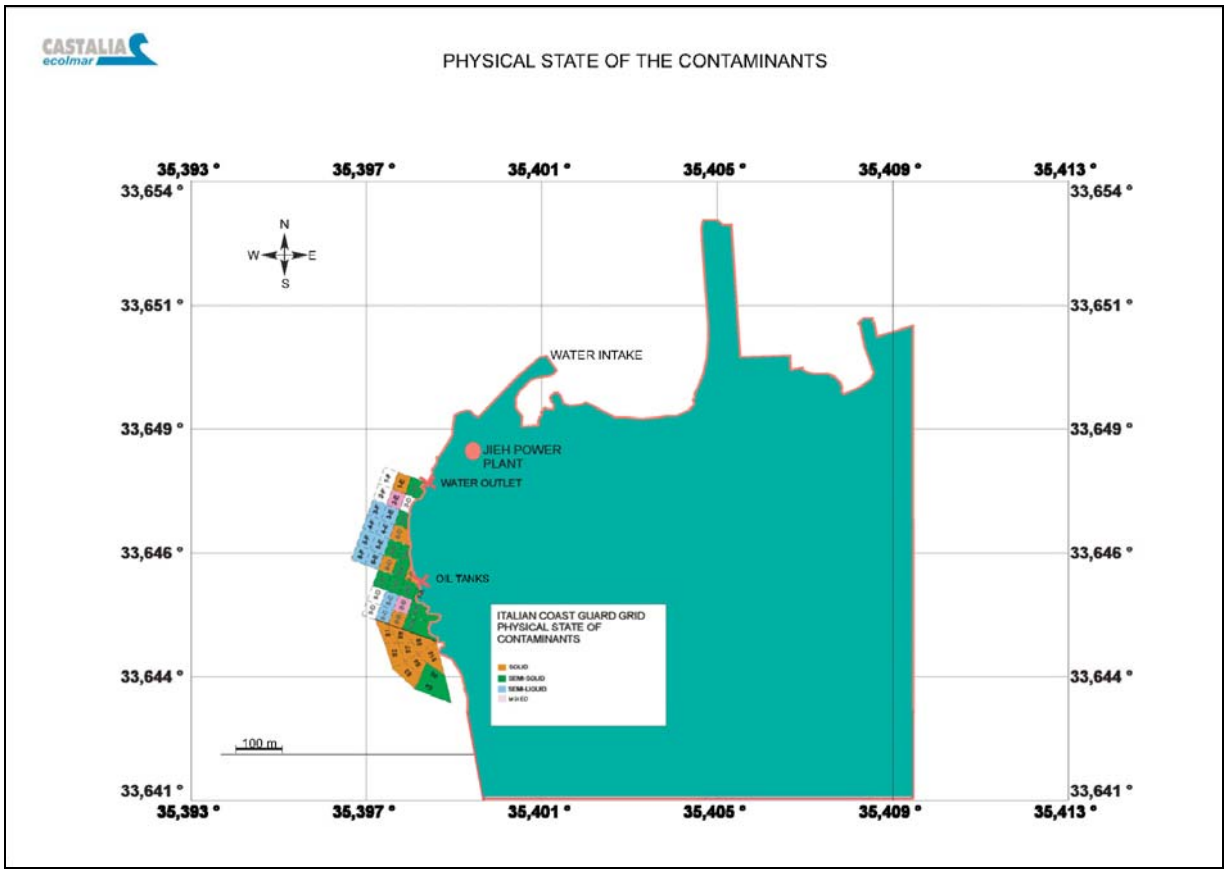


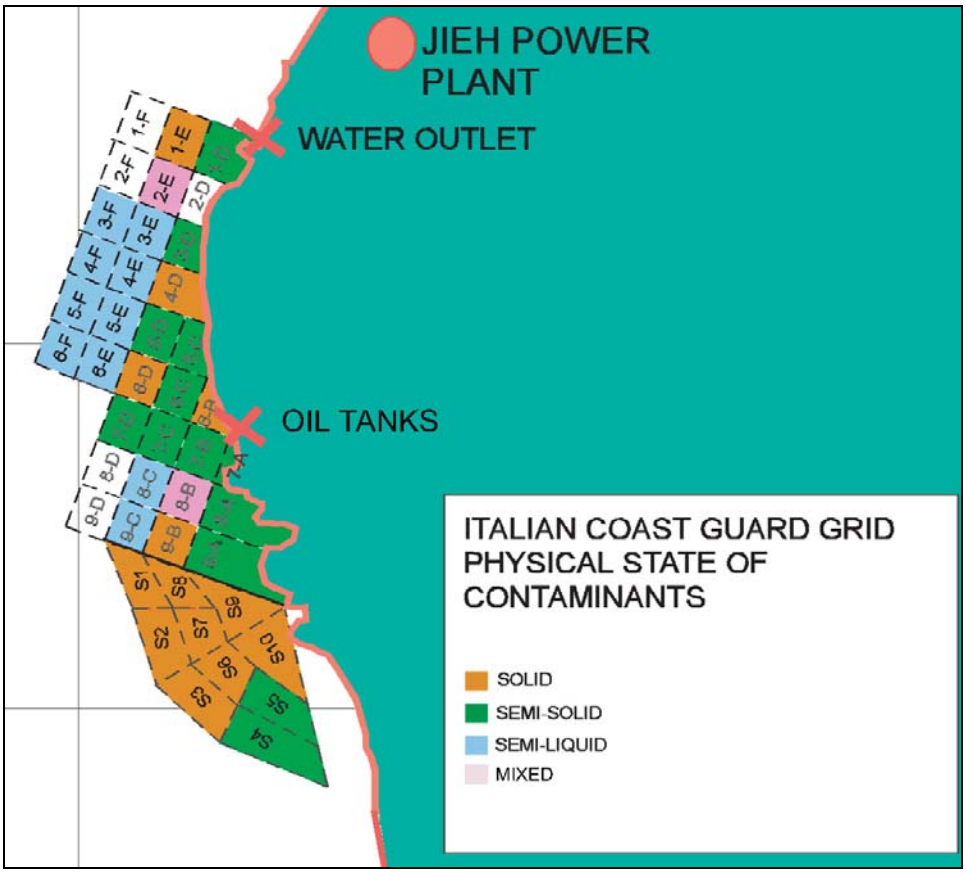
Figures 2a - 2b

Particularly, an high contamination level indicates the presence of polluting material in every gorge visible through the cliffs, a medium contamination identifies the presence of product in about the 50% of the gorges, a low contamination is related to polluting material in less than 50% of the gorges.

Subsequently, it appears evident that in a cell classed as “area of low contamination” the total quantity of polluting product could be larger than the one present in an “area of high contamination”, because of the structure and the depth of the gorges.

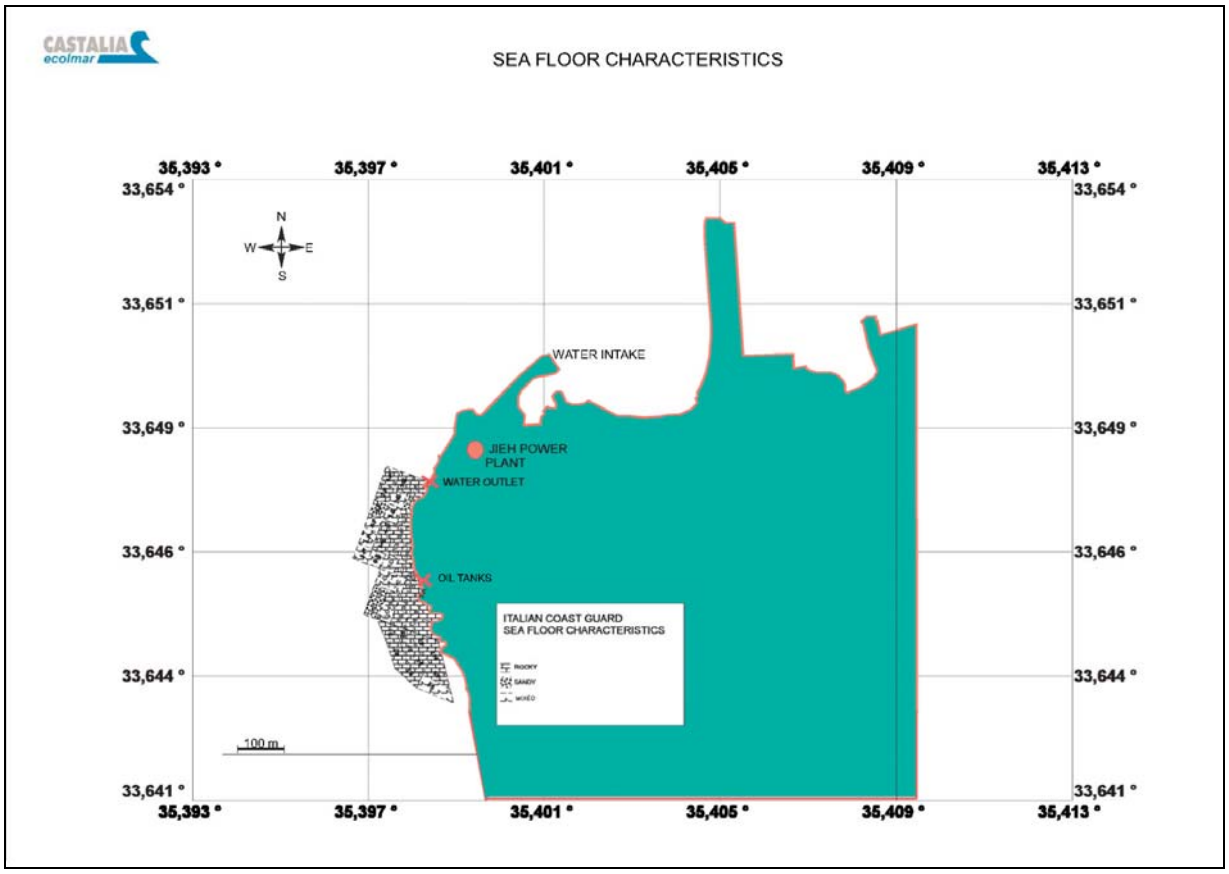
For every cell inspected, the physical state of the product has been underlined (solid, semi-solid, semi-liquid, mixed – see fig. 3a -3b).


PHYSICAL STATE OF THE CONTAMINANTS
35,393 °
35,397 °
35,401 °
35,405 °
35,409 °
35,413 °
33,654 °
33,651 °
33,649 °
33,646 °
33,644 °
33,641 °
N
W
E
S
WATER INTAKE
JIEH POWER PLANT
WATER OUTLET
OIL TANKS
ITALIAN COAST GUARD GRID
PHYSICAL STATE OF CONTAMINANTS
SOLID
SEMI-SOLID
SEMI-LIQUID
MIXED
100 m



Figures 3a – 3b

For every cell inspected, the characteristics of the sea floor have been underlined (rocky, sandy, mixed – see fig. 4a -4b).


SEA FLOOR CHARACTERISTICS
35,393 °
35,397 °
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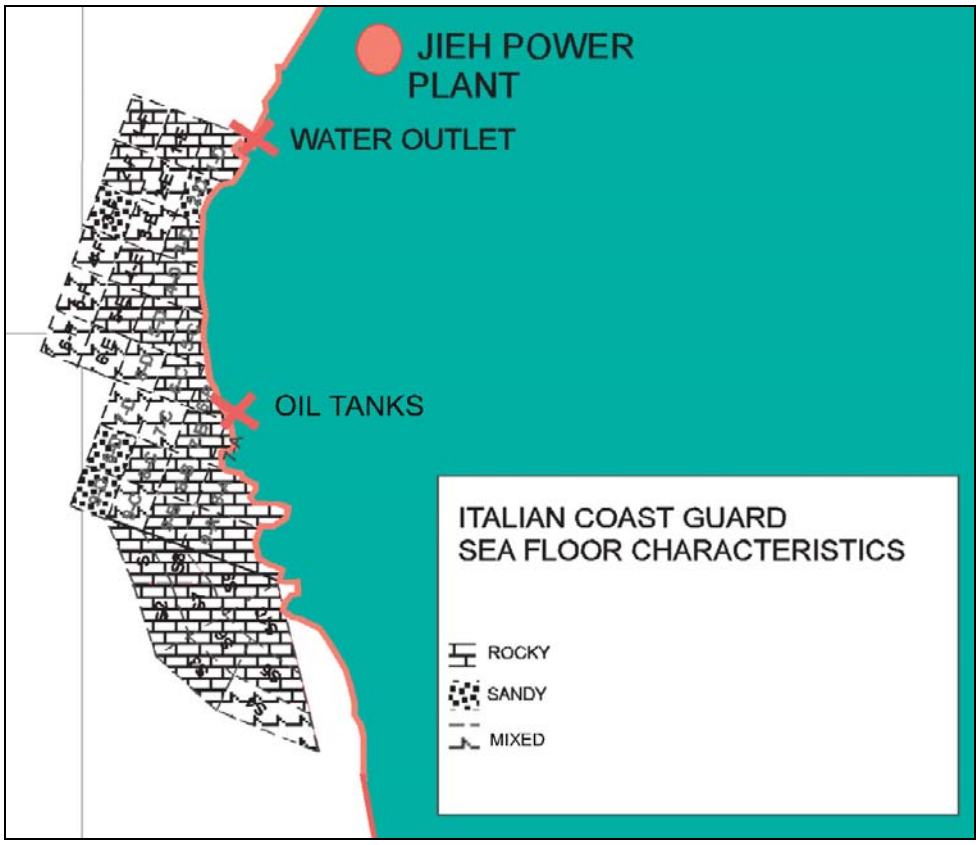
WATER OUTLET
OIL TANKS
ITALIAN COAST GUARD
SEA FLOOR CHARACTERISTICS
ROCKY
SANDY
MIXED
100 m



Figures 4a – 4b

On the basis of the direct inspections carried out by the divers and after the ROV surveys conducted on the external areas, the contamination has resulted as particularly focused on the area identified by the grid, facing the spill point. This contamination can be described as follows:

1- Three typologies of hydrocarbons are present:
   - the first, that can be defined as “solid”, constituted by black porous solid fragments, similar to pumice, irregular shapes and variable sizes (even 50cm). This product represents the carbonizated fraction of the oil spilled at sea.

Figure 5: solid product

- the second typology is constituted by almost solid doughy fragments.

Figure 6: semi-solid product

- the third, almost liquid consists in a viscose liquid solution.

Figure 7: semi-liquid product

2- The sea bottom in the area is prevalently rocky, with shore alternating with craters and groves.

3- The contamination is focused on the rocky areas between the shores, and often covering sand and vegetation are present. These conditionsw cause relevant difficulties to the visual identification of the product.

4- The little sandy areas, do not present surface contamination. The surveys carried out by the divers point out in some zones the presence of product, submerged by a considerable thickness of sand (from 30 to 50 cm).

5- It appears impossible to estimate the total quantity of present product because its distribution is absolutely irregular and the morphology of the gorges, where the material is present, is unknown.

6- It is not possible to exclude the presence of product covered by sand with thickness of more than 50 cm.

7- It seems correct to exclude the presence of about 15.000 tons of product, as assumed before the starting up of the operations, also because of the size of product until now removed from the contaminated areas.

   It seems reasonable to assume that the total quantity of product present in the contaminated area, as residual from the current and wind actions, could be evaluated, before the starting up of remediation activities, in some hundred tons.

4. Description of the preliminary activities of remediation

In the first step of the operations, in the area near the outlet of the power plant's cooling system and in the area in front of the tanks, the pollutant has been manually removed by the divers with the support of S/V Tito's tender. The activities have been conducted always at a certain distance from the coastline where the NGO BAHAR LUBNAN operations were already running.

Figure 8

The air suction pump system has been selected as an option, before the S/V Tito's departure from Livorno, on the basis of the available information regarding the product involved, the large quantities declared (15.000 Tons) and because analogue cases demonstrated the efficiency of this system.

In order to remove the exceeding water collected by the air suction pump, an oil restraint and water drainage system has been designed and built on site.
This system has been made with metal baskets of proportioned dimensions with the restraint and storage system available (1m³ big bag with a breaking strength of 1000Kg) covered with geotextile in order to drain the exceeding water.

The baskets were equipped with extendable doors on the bottom in order to unload the collected products inside the big bags.

Figure 9

Figure 10

After few extraction tests two handy air suction pumping systems have been built in situ.

In order to protect the power plant's water intake area, the small bay has been closed by a vertical net and sorbent booms anchored to the bottom with weights to contain the possible floating pollutants.

Figure 11

Moreover two coastal booms sections have been placed to protect the sea from possible spilling coming from the area where was stored the product collected by NGO BAHAR LUBNAN divers.

Figure 12

5. Air suction pumps technology experimentation and technical considerations

As a consequence of the results of the hand-operated collection and the remediation operations conducted with the air suction pump, the following conclusions can be exposed:

Figure 13

- After a technical evaluation in terms of removal efficiency and in terms of time, the best way to remove the solid product is the manual recovery operated by divers.

  This technique has been, in fact, used in the removal activities in the following areas: 4D-6D-9B-S1-S2-S3-S6-S7-S8 (see figure 1a-1b).

  The solid product, to be recovered with the air suction pump, should have been mechanically fragmentized using high pressure water jet.

  These operations would have slowed down considerably the recovery activities and would have reduced the visibility in the area with negative effects on the marine environment.

Figure 14

- The semi-solid product is suitable to be recovered with the air suction pump. This technology has been employed in the cells 5C, 6C 7C, 7B and 8B with satisfying results. The application of this technology has been applied only in the areas with significant presence of semi-solid product.

  Once concluded the activity on sectors C, the pumpable product with the utilized criteria, remained concentrated in few areas near to the shoreline (cells 7B-8B and S4-S5) with consequent limitations for manoeuvring and anchorage of the pontoon. On the above mentioned areas the operations have been conducted with the air suction pump when the weather conditions were favourable.

Figures 15a -15b: aspirated semi-solid product

- The semi-liquid product was impossible to be manually removed because of its consistency. The 8C and 9C areas, in fact, have been treated with the air suction pump.
  Nevertheless, the efficiency of this system was reduced because it would have been necessary, to obtain good results, to have a barge/water tight containers available to collect the removed product.

  In some areas the semi-liquid product was covered by a thick layer of sand. In this case has been decided not to operate with the air suction system

because it would be pumped more sand than pollutant, with negative effects on the marine environment.

Furthermore the air suction pump system has been evaluated not convenient for the scattered semi-liquid product.

The semi-liquid product is still present in non-relevant quantities in the E and F rows and some residues are left in the 8C and 9C areas.

This remaining product could be removed in a second step of the remediation activities with air suction or with the use of cohesive materials (as fine-knit nets) able to adhere with the product.

Figures 16a -16b: aspirated semi-liquid product

Considering the above evaluation, the team of divers, initially constituted by 4 operators, starting from the 8th of October was integrated by the Italian Ministry of Environment with an additional team of 4 divers to provide more manpower to perform the manual recovery activities.

6. Description of remediation activities and obtained results

The operational areas were:

- **1D, 3D, 4D, 5D, 6D, 5C:** remediation with manual recovery before the pontoon arrival
- **6C, 7C, 8C, 9C, 7B**, **8B:** remediation with manual recovery in the first period and with the air suction pump after the pontoon arrival
- **S1, S2, S3, S6, S7, S8:** characterized by solid product and therefore operated with manual recovery.

Figure 17: Manual Recovery Activities

Figure 18: Manual Recovery Activities

The criteria employed to leave one single cell and start the cleaning operations in an other cell was based on the flux of material recovered under an evaluation of cost-benefits of the intervention and take into consideration the total time available for the activity.

When in a determined area the collection needed time was too elevate with the respect to the quantity recovered, because of the low pollutant quantity present or its scattered distribution, it has been established to consider the area no more convenient to be remediated. Then, an other area that allowed higher rates of recovery, was chosen.

The following list of activities is the report of daily operations in terms of recovered materials, cells treated and numbers of divers employed for the operations.

DATE	DESCRIPTION OF ACTIVITIES	Number of divers	hour/divers	hours tot	Collected quantities m^3	Treated cells
23/09/06	At 12 A.M. the S/V Tito moors at the Sibline quayside in Jieh				-	-
24/09/06	Underwater survey and sampling with divers- Survey in the water intake bay with ROV				-	-
25/09/06	Test of air suction pump (air suction pump)	2	2	4	-	-
26/09/06	Starting of sea floor clean up activities with manual removal of pollutant. In the afternoon operations stop because of adverse weather conditions. Placing of vertical net and sorbent booms in order to protect the water intake	2	3	6	0,1 m^3	1D
27/09/06	Sea floor clean up activities with manual removal of pollutants	3	4	12	2 m^3	1D
28/09/06	Sea floor clean up activities with manual removal of pollutants. In the afternoon operations stop because of adverse weather conditions.	2	4	8	1 m^3	3D - 4D
29/09/06	Sea floor clean up activities with manual removal of pollutants. In the afternoon operations stop because of adverse weather conditions.	2	3,5	7	1 m^3	5 D
30/09/06	Adverse weather conditions	2	2,5	5	-	-
01/10/06	Adverse weather conditions				-	-
02/10/06	Sea floor clean up activities with manual removal of pollutant	2	4,83	9,66	2,4 m^3	6D - 7D
03/10/06	Sea floor clean up activities with manual removal of pollutant	2	5	10	1,5 m^3	5C
04/10/06	Sea floor clean up activities with manual removal of pollutant	2	4,83	9,66	1 m^3	7C
05/10/06	Sea floor clean up activities with manual removal of pollutant	2	4	8	-	7C
06/10/06	Sea floor clean up activities with manual removal of pollutant	2	5	10	0,4 m^3	7C
07/10/06	Sea floor clean up activities with manual removal of pollutant	2	4	8	0,3 m^3	8C
08/10/06	Sea floor clean up activities with manual removal of pollutant	2	5	10	0,6 m^3	6C
09/10/06	Sea floor clean up activities with manual removal of pollutant	4	3,83	15,32	-	6C
10/10/06	Sea floor clean up activities with manual removal of pollutant	4	3,83	15,32	0,5 m^3	6C
11/10/06	Sea floor clean up activities with manual removal of pollutant	4	4,37	17,48	0,5 m^3	6C

12/10/06	Sea floor clean up activities with manual removal of pollutant	4	4,5	18	1,4 m^3	6C
13/10/06	Sea floor clean up activities with manual removal of pollutant – Recovered products are left on the sea floor into a big bag	4	2,25	9	-	-
14/10/06	The barge arrives in Jieh - Test of air suction pump (air suction pump)			0	-	-
15/10/06	Adverse weather conditions			0	-	-
16/10/06	Adverse weather conditions			0	-	-
17/10/06	Adverse weather conditions			0	-	-
18/10/06	Aspiration of the contaminants with air suction pump Products manually recovered in date 13/10	6	5	30	2,5 m^3 1 m^3	6C - 6D 6C
19/10/06	Aspiration of the contaminants with air suction pump - In the afternoon operations stop because of adverse weather conditions	6	5	30	1 m^3	6C - 8C
20/10/06	Adverse weather conditions			0	-	
21/10/06	Aspiration of the contaminants with air suction pump	6	4	24	1,5 m^3	9C
22/10/06	Sea floor clean up activities with manual removal of pollutant	6	3,5	21	4 m^3	S1 -S8
23/10/06	Sea floor clean up activities with manual removal of pollutant	6	3,83	22,98	2 m^3	S1 - S8
24/10/06	Sea floor clean up activities with manual removal of pollutant	6	3,5	21	2 m^3	S2 -S7
25/10/06	Sea floor clean up activities with manual removal of pollutant	6	3,5	21	1,5 m^3	S3 -S6
26/10/06	Aspiration of the contaminants with air suction pump	6	3	18	2,2 m^3	7B -8B
27/10/06	Adverse weather conditions			0	-	-
28/10/06	Adverse weather conditions			0	-	-
29/10/06	Adverse weather conditions			0	-	-
30/10/06	Sea floor clean up activities with manual removal of pollutant and aspiration of the contaminants with air suction pump	4	3,5	14	0,4 m^3	S3
31/10/06	Aspiration of the contaminants with air suction pump - In the afternoon operations stop because of adverse weather conditions Some materials collected from meshe S6, were left into a big bag on the sea floor and as accorded with NGO BAHAR LUBNAN local divers will collect them	4	2	8	0,7 m^3	7B -8B
01/11/06	Adverse weather conditions				-	-
02/11/06	Adverse weather conditions				-	-

table 1

As exposed in table 1, 31,5 m^3 of product (equivalent to about 40 tons) have been recovered in 392,4 hours of underwater activity. The operation performance is an average of 0,08 m^3. per single diver per hour.

7. Waste management

In the first period, before the pontoon arrival, the divers operated with the support of the tender of the S/V Tito. The product manually recovered on the sea bottom was stored in canvas bags on the sea bottom itself and then on big bags. At the end of each day the big bags were transported with the aid of floating balloons to the S/V Tito and lift on board with the crane. During the lifting operation the material was drained of the water in excess.

Figure 19: drainage of excess water

After the pontoon arrival the big bags resulting form the manual recovery were directly lifted onboard with the pontoon's crane and given to the truck service provided by the Lebanese Ministry of Environment at the end of the activities.

Figure 20

For the operations conducted with the air suction pump the material recovered into the baskets, once drained from the water in excess, was unloaded into the big bags.

Figure 21

All the big bags with the recovered materials have been closed with American tape and labelled with progressives alphanumeric initials (see table 2).

The total quantity of the material recovered (about 31,5 m^3) is constituted for the 80% of almost pure hydrocarbons product deriving from the manual collection.

Figures 22a -24b: big bags with manually collected products

About 7,2 m^3, recovered with mechanical means, are characterized by product mixed with sand. The estimation of sand quantity in the mixture is of about 60 %.

Figure 23: big bag with aspirated products mixed with sand

During the activities have been moreover produced waste like sorbent booms (72 sections), oily overall, oily gloves, oily ropes, etc. that have been stored in separated big bags.

Figure 24: temporary storage area

List of Big Bags disposed and date of the transport in the temporary storage area

Date of disposal	BIG BAG 1m^3	CONTENTS	DRUMS 200 liters	CONTENTS
		Oily wastes (work gloves,		
13/10/2006	JC1	ropes, overalls…)		
	JC2	Tarry products		
	JC3	Tarry products		
	JC4	Tarry products		
	JC5	Tarry products		
	JC6	Tarry products		
	JC7	Tarry products		
	JC8	Tarry products		
	JC9	Tarry products		
	JC10	Tarry products		
18/10/2006	JC11	Tarry products	JC14	Tarry products
	JC12	Tarry products		
	JC13	Tarry products		
	JC15	Tarry products		
	JC16	Tarry products		
	JC17	Tarry products		
	JC18	Tarry products		
	JC19	Tarry products		
	JC20	30 meters sorbent booms		
	JC21	24 meters sorbent booms		
24/10/2006	JC22	Tarry products	JC30	Tarry products
	JC23	Tarry products		
	JC24	Tarry products		
	JC25	Tarry products		
	JC26	Tarry products		
	JC27	Tarry products		
	JC28	33 meters sorbent booms		
	JC29	Tarry products		
27/10/2006	JC31	Tarry products		
	JC32	Tarry products		
	JC33	Tarry products		
	JC34	Tarry products		
	JC35	Tarry products		
	JC36	Tarry products		
	JC37	Tarry products		
	JC38	Tarry products		
	JC39	Tarry products		
		18 meters sorbent booms		
	JC40	– oily buoys and ropes		
	JC41	24 meters sorbent booms		
	JC42	Tarry products		
03/11/2006	JC43	Tarry products		
	JC44	Tarry products		
	JC45	15 meters sorbent booms		
	JC46	24 meters sorbent booms		
06/11/2006	JC47	24 meters sorbent booms		
	JC48	24 meters sorbent booms		

table 2

8. Conclusions

According to the considerations above exposed and with concern of the experimental results of the clean up activities, it is possible to conclude the following:
Considering:

- the physical state of the contamination products,
- the irregular distribution of the contamination in the interested area (scattered spots),
- the characteristics of the sea floor (predominantly rocks with deep ravines),
- the need to carry out a manual intervention with divers also in the case of use of the air suction pump (e.g. finalized to take off the products from the rocks or to convey the semi-solid scattered products to the mouth of the air suction pump),

and with the aim to minimize marine environmental impacts, the aspiration technology (air suction pump), generally utilized in the removal interventions of hydrocarbons products from the sea floors, in this situation of contamination and with all the limitations above exposed, is resulted not always suitable and effective.
An exception is the case of some areas of particular characteristics (large concentrations of semi-solid products located on top of the sea floor).
Nevertheless, these areas are located near the shore line, where the wave motion is stronger, and consequently it was more difficult to operate there with the barge and the divers.
For all these reasons, the manual removal of hydrocarbon pollutants from the sea floor is showed to be the best technology in terms of effectiveness, outputs, costs and durations of the intervention and, finally, in terms of limitation of marine environmental damages.

Considering an amount of 43 cells in the individuated grid, the Italian team treated 19 cells (1D, 3D, 4D, 5D, 6D, 7D, 5C, 6C, 7C, 8C, 9C, S1, S2, S3, S6, S7, S8, 7B, 8B) corresponding to a percentage of about 44% of the total interested area.

About the 19 treated cells:

- 15 cells (5C, 6C, 7C, 8C, 9C, 1D, 3D, 4D, 5D, 6D, 7D, S1, S2, S7, S8) resulted almost remediated.
- 4 cells (S3, S6, 7B, 8B) are yet interested by the presence of removable hydrocarbons residues.

Assuming that 5 cells (1F, 2F, 2D, 8D, 9D) of the total 43 are considered at a zero or very low level of contamination, the total number of the polluted cells gets down to 38 and the above percentage grows to 50%.
Furthermore considering that NGO BAHAR LUBNAN treated, during the operation period, 6 cells (6B, 7A, 8A, 9A, S9, S10) of the grid, near to the shore line, the total number of cells under the competence of the Italian team gets down to 32 and the percentage of the treated area grows to 59%.

In the second step of the clean up operations the areas to be treated will be 7B-8B, S4-S5 and the contaminated spots located in some cells of the lines E and F of the grid. If the duration of the second intervention will be compatible, it will be possible to remove the residues of contamination in the cells S1, S2, S7, S8 and in the cells of the C and D line.

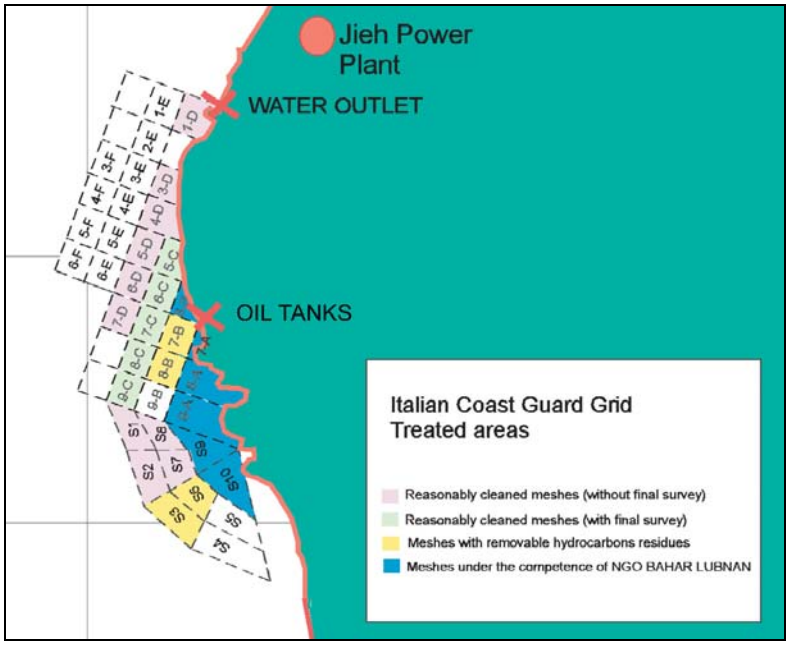


Figure 25